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1/4 DIN PROCESS CONTROLLER USER'S MANUAL

MOORE INDUSTRIES

M545 V6, JANUARY 2005

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About This Manual:
Throughout this User's Manual information appears along the margins, in the form of **NOTE**s, **CAUTION**s and **WARNING**s, usually in **boldface**. Please heed these safety and good practice notices for the protection of you and your equipment.

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CHAPTER 1
INTRODUCTION

From its surge-resistant power supply to its rugged construction, the 545 process controller is designed to ensure the integrity of your process with maximum reliability — hour after hour, day after day. The isolated inputs and outputs guard against the dangers of electrical interference, the front face meets NEMA 4X standards for watertight operation and exposure to corrosive environments, and the solid metal housing and sturdy rubber keys enhance durability and ESD protection.

The 545 has been engineered to be the industry's most user–friendly process controller. With three digital display areas — two offering up to 9 characters of true alphanumerics — the 545 effectively eliminates the cryptic messages that could confuse even the most experienced operator. The bright, crisp display is vacuum fluorescent, and offers much better readability than any other display technology. Additional operator–friendly features include: custom programmable alarm messages, illuminated keys, and an easy to use menu system.

The 545 is the most accurate instrument in its class. With a sampling rate of eight times per second, it is ideal for demanding pressure and flow applications. The 545 also offers two universal process inputs and modular, field interchangeable outputs that allow more flexibility than ever before. With two independent full feature control loops, the 545 can take the place of two PID controllers; additionally, preprogrammed functions can be called for cascade, ratio and feed forward applications.

The 545 uses foreground and background loops that facilitate straight forward operator interface in any of the dual loop modes. It also offers sophisticated control algorithms, including heuristic adaptive tuning, split range and duplex outputs (control), and open or closed loop electric actuator control (velocity control).

Thank you for selecting the dual loop Process Controller. The 545 is user-configurable for any of the following functions:

- Two independent PID loops
- Single Station Cascade Control
- Single Station Ratio Control
- Feed Forward Control

Specifications and information subject to change without notice.

545 MODES

There are three operating modes for the 545 controller:

OPERATION, the default mode of the controller. When the 545 is operating, you can change setpoints, select manual control and change output level, acknowledge alarms and monitor conditions.

SET UP, also referred to as configuration. Here you set up the basic functions of the instrument such as input and output assignments, alarm types and special functions

TUNING, where you configure function parameters for Proportional, Integral and Derivation (PID) control. Use this mode periodically to optimize the control performance of the instrument.

ORDER CODE, PACKAGING INFORMATION

Comparing the product number to the ordering code on page 3 to determine the outputs and options installed on the 545. The product number is printed on the label on the top of the controller case.

Included with the 545 are:

- a 545 User's Manual
- mounting hardware
- 1 sheet engineering unit adhesive labels

WHERE TO GO NEXT

- To become more familiar with the 545 interface, continue to Chapter 2.
- For important hardware installation guidelines, see Chapters 3 and 4.
- For a detailed description of all the software menus and parameters of the 545, follow through Chapter 5 and 6. Appendix 1 can be used as a guide to these parameters.

TEXT FORMATTING IN THIS MANUAL

Feature	Format	
KEYS	**SET PT**	**DISPLAY**
	or	
	SET PT	**DISPLAY**
ICONS	OUT, ALM	
MENUS	CONFIG., TUNING,	
PARAMETERS	CYCLE TM:1, MIN.OUT2	
PARAMETER VALUES	OFF, SETPOINT, LAST OUT.	
DISPLAY MESSAGES	TOO HOT, OUT%	

545 – □ □ □ □ □ □ □ □ 0 0

	Order Code
Output 1: Control	
None	**0**
Mechanical Relay (5 amp)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (1 amp)	**3**
DC Logic (SSR drive)	**4**
Output 2: Control, Alarm, or Retransmission	
None	**0**
Mechanical Relay (5 amp)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (1 amp)	**3**
DC Logic (SSR drive)	**4**
Output 3: Control, Alarm, Retransmission, or Loop Power	
None	**0**
Mechanical Relay (5 amp)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (1 amp)	**3**
DC Logic (SSR drive)	**4**
Loop Power	**5**
Output 4: Control, Alarm, Retransmission, or Loop Power	
None	**0**
Mechanical Relay (0.5 amp, 24 V)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (0.5 amp, 24 V)	**3**
DC Logic (SSR drive)	**4**
Loop Power	**5**
Options	
Enter "0" if not desired	
Slidewire Feedback for Position Proportioning Output	**A**
24 VAC/24VDC Operation	**F**
Slidewire and 24 VAC/24VDC	**G**
Remote Setpoint	**B**
Set of Five Digital Inputs	**D**
CE Certification	**H**
Five Digital Inputs and CE Certification	**J**
Serial Communications	
Enter "0" if not desired	
RS-485 Serial Communications	**S**

Note 1: Capability for position proportioning output with slidewire feedback is specifed by ordering 545-11xxAxxx00, 545-33xxAxxx00, or 545-44xxAxxx00. (Slidewire not required for velocity proportioning.) **Note 2:** Up to three outputs may be used for alarms. **Note 3:** All outputs are interchangeable modules. **Note 4:** The mechanical relay and solid state relay modules are derated to 0.5 amp at 24 Vac when used as the fourth output.

Introduction

CHAPTER 2
CONTROLLER OPERATION

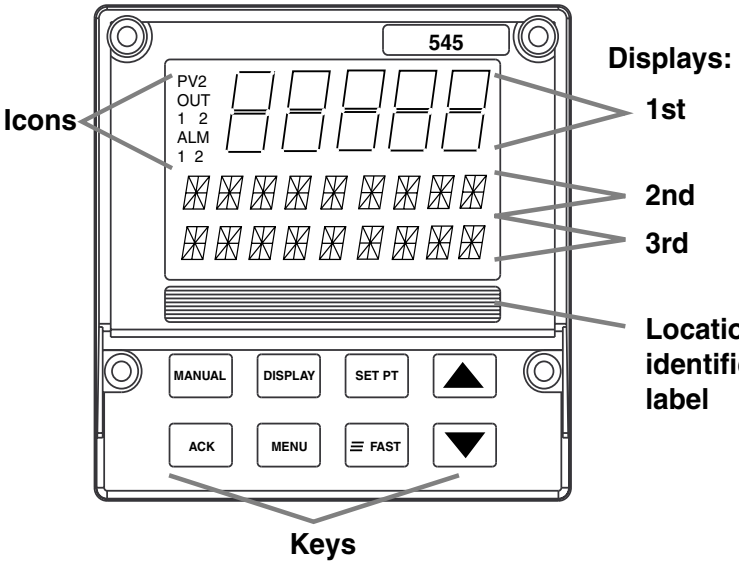


Figure 2.1
Operator Interface

DISPLAYS

The display strategy of the 545 Process Controller is the same for all control modes: Dual Loop, Cascade, Ratio and Feed Forward.

1st Display (five 7-segment digits)

- For the process variable value.

2nd Display (nine 14-segment digits)

- For the setpoint, deviation, output value or valve position (if available).
- In **TUNING** or **SET UP** mode, for the parameter name.
- Upon power up, indicates the current setpoint.

3rd Display (nine 14-segment digits)

- Name of current foreground loop
- For alarm messages, errors, etc.
- In **TUNING** or **SET UP** mode, for the value or choice of parameter shown in the 2nd display.

ICONS (LIT)

PV2 Loop 2 is in the foreground (on display); Loop 1 is in the background.

OUT1 For this output, either the relay output is energized or the analog output is greater than 0%.

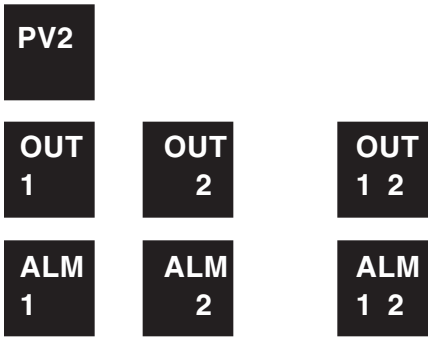
OUT2 For this output, either the relay output is energized or the analog output is greater than 0%.

If control output is analog, indicates the output is greater than 0%.

ALM 1 The respective alarm (one) is active.

ALM 2 The respective alarm (two) is active.

ALM An alarm is active but no output is assigned.



KEYS

FAST — **FAST:** Has no independent function. Press to modify the function of another key (see below).

MANUAL — **MANUAL:** Press to toggle between manual and automatic control.
When lit, indicates the unit is under manual control.

SET PT — **SET PT:** Press to select the active setpoint.
In SET UP or TUNING mode, press to return controller to OPERATION mode.
When lit, indicates that a setpoint other than the local SP1 is active.

DISPLAY — **DISPLAY:** Press to toggle through values in the 2nd display for setpoint, ramping setpoint (if available), deviation, output. background PV, lag (if available) and valve position (if available).
In SET UP or TUNING mode, press to return controller to OPERATION mode (with display showing current setpoint).
When lit, Loop 2 is in the foreground.

FAST + DISPLAY — **FAST+DISPLAY:** Toggles between the background loop and foreground loop.

▲ — **▲ :** Press to increase the value or selection of displayed parameter.

FAST + ▲ — **FAST+▲ :** Press to scroll through values at a faster rate.

▼ — **▼ :** Press to decrease the value or selection of displayed parameter.

FAST + ▼ — **FAST+▼ :** Press to scroll through values at a faster rate.

ACK — **ACK:** Press to acknowledge (an) alarm(s).
When lit, indicates there is an acknowledgeable alarm.

MENU — **MENU :** In OPERATION Mode, press to access the TUNING mode and menu.
In Set Up or Tuning mode, press to advance through a menu's parameters. (Use **FAST+MENU** to advance to the next menu.)
When lit, indicates the controller is in SET UP mode.

FAST + MENU — **FAST+MENU:** Press to access the Set Up menus.
In SET UP mode, press to advance through menus. (Use **MENU** by itself to access the parameters of a particular menu.)

BASIC OPERATION PROCEDURES

A Quick Explanation of Dual Loop Operation

Upon power up, Loop 1 is in the foreground (displayed), and Loop 2 is in the "background" (hidden). Set up changes only affect the foreground loop; to make changes to the operation of the background loop, it must be brought to the foreground.

The controller helps the user identify the foreground and background loops with the following:

- When Loop 2 is in foreground **DISPLAY** key and the **PV2** icon are lit
- The third display will show a message identifying the foreground loop.

Use the following as a quick guide to key operating functions of your 545. Most of these procedures will affect whichever loop is in the foreground at the time you execute the procedures. Those that are specified by the word **GLOBAL** will affect both loops (the whole controller).

To switch the foreground and background loops

1. Press **FAST+DISPLAY.**

To select /change a setpoint

1. Use **DISPLAY** key to toggle display to Set Point.
2. Use **SET PT** key to toggle to active setpoint.

   Before the newly selected setpoint is made active, there is a two-second delay to prevent any disruptive bumps. If the setpoint displayed is ramping, RAMPING will show the 3rd display.
3. To change value, press ▲ or ▼ .

NOTE:
See the glossary in Appendix 6 for explanation of *ramping* and *target setpoint*. Also refer to the section in Chapter 7.

To change from auto to manual control (bumpless transfer)

1. When in automatic control, press the **MANUAL** key at any time, except while in the **TUNING** mode.
2. The **MANUAL** key will light in red, and the 2nd display will immediately change to indicate current output level.

To change from manual to auto

1. When in manual control, press **MANUAL** at any time except while in the **TUNING** or **SET UP** mode.
2. The 2nd display will not change, and the **MANUAL** key will no longer be lit once control changes.

To change manual output values

1. Make sure the controller is under manual control.
2. Use the **DISPLAY** key to toggle 2nd display to output level.
3. Use the ▲ or ▼ key to change the value.

To override security

If a locked operation is attempted, **SECURITY** appears in the 2nd display for two seconds.

1. Use the ▲ and ▼ keys to quickly enter the security code, which will show in the 3rd display. The starting value is 0.

   Note: Two seconds of key inactivity will clear the display.
2. If the code is correct, **CORRECT** appears in the 3rd display. The display will clear after two seconds, allowing full access.

4. If code is incorrect, **INCORRECT** appears in the 3rd display. INCORRECT will disappear after two seconds, and a new security code can then be entered.
5. The controller will revert back to full security lock after one minute of key inactivity.

To display control output value

1. Toggle **DISPLAY** key until the 2nd display shows OUT followed by the output percentage. This value is the PID output.
   - In duplex applications, this value does not directly refer to the output signal (refer to the Chapter 7 section on Duplex Control for details.)
   - For on/off outputs, the output value shown is either ON or OFF.
   - For duplex applications with two on/off outputs, the OUT tag is not shown. In this case, the status of both outputs is shown in the following manner: 1:ON 2:OFF (1 and 2 are the respective outputs).

To display the active PID set

1. Select the desired foreground loop (hold **FAST**, press **DISPLAY**).
2. Press **MENU** to reach Tuning Mode.
3. In **TUNING** Mode, press **MENU** to reach the correct Menu parameter.
4. The active PID set will have an asterisk (*) on both sides of the value.

ALARM OPERATION

NOTE:
All alarms are software alarms unless tied to an output relay in the SET UP mode. See Chapter 5 and Chapter 7 for more details on alarms.

Alarms may be used in systems to provide warnings of unsafe conditions. All 545 operators must know how the alarms are configured, the consequences of acknowledging an alarm, and how to react to alarm conditions.

Alarm Indication

Depending on how the system is configured, the 545 indicates an alarm condition(s) for the **foreground loop** by:

- Lit icons **ALM 1** and/or **ALM 2**
- Lit **ACK** key
- Displayed alarm message

The 545 indicates an alarm condition(s) for the **background loop** by:

- Showing the (user defined) message for one or both alarms in the third display (alternate displays for simultaneous alarms).

To acknowledge an alarm(s):

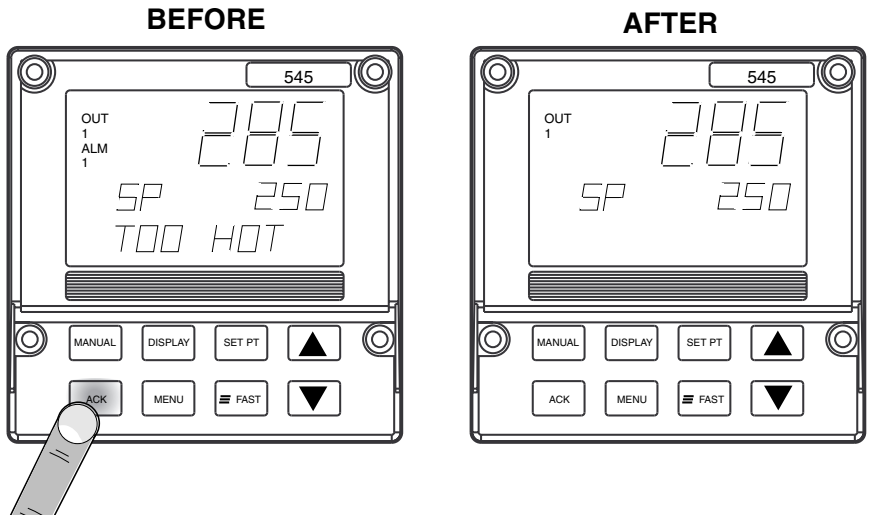
An **acknowledgeable** alarm has both a lit icon and a lit **ACK** key.

A **non-acknowledgeable** alarm has only a lit icon.

Figure 2.2 demonstrates acknowledging an alarm.

1. If the alarm is in the background, bring that loop forward using **FAST+DISPLAY**.
2. To acknowledge Alarm 1, press **ACK** once.
3. To acknowledge Alarm 2, press **ACK** twice.
4. If both alarms are activated, press **ACK** once to acknowledge Alarm 1, then again to acknowledge Alarm 2.

5. The message and alarm icon disappear.



NOTE:
Powering down the 545 acknowledges/ clears all latched alarms. When powering up, all alarms will be reinitialized.

Figure 2.2
Before and After Acknowledging an Alarm

Latching Alarms

If an alarm is set up to be latching (for details, see Chapter 5) then, in general, it must be acknowledged in order to clear the alarm and release the relay (if applicable). A non-latching alarm will clear itself as soon as the process leaves the alarm condition.

Limit Sequence

An alarm can be configured to be both latching and non-acknowledgeable. In this case, the alarm is acknowledgeable only after the process has left the alarm condition. This is similar to the function of a limit controller.

More on Alarms

For more details on how to set up alarms and for examples of various ways alarms can be set up, refer to the section on Alarms in Chapter 7.

Basic Interface

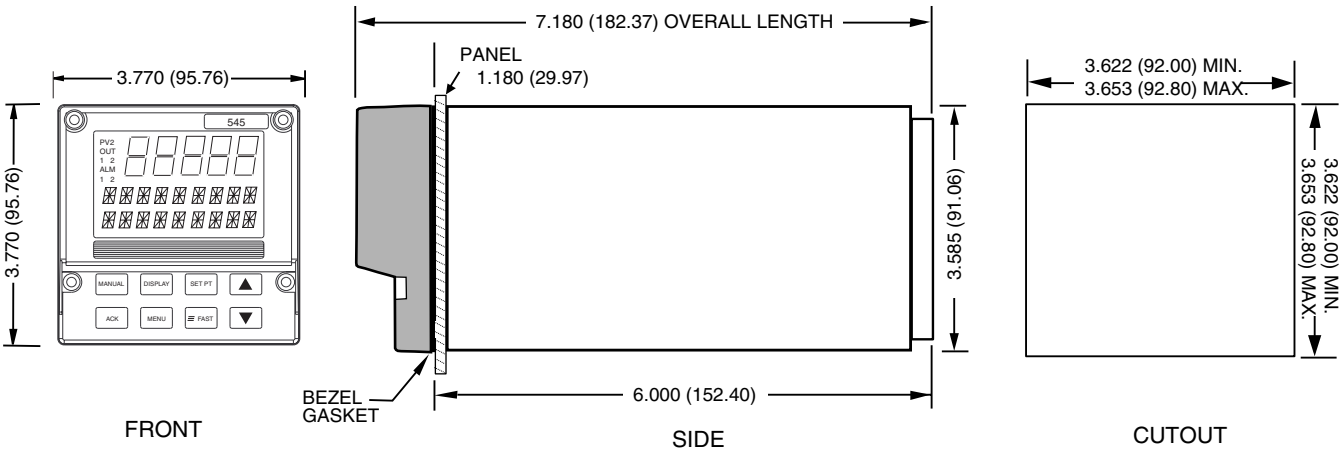
CHAPTER 3
INSTALLATION AND WIRING

MOUNTING THE CONTROLLER

The 545 front face is **NEMA 4X rated** (waterproof). To obtain a waterproof seal between the controller and the panel, follow these directions:

1. The 545 fits in a standard 1/4 DIN cutout. Mount the 545 in any panel with a thickness from .06 in. to .275 in. (1.5 mm to 7.0 mm).
2. Figure 3.1 shows the controller and panel dimensions. The panel cutout must be precise, and the edges free from burrs and waves.

Figure 3.1
Instrument Panel & Cutout Dimensions



3. Place bezel gasket around the controller case (starting at the back of controller). Then, slide the gasket against the back of the bezel.
4. With the bezel gasket in place, insert the 545 into the panel cutout from the front of the panel.
5. Slide the mounting collar over the back of the case, as shown in Figure 3.2. The collar clip edges will lock with matching edges on the controller case.

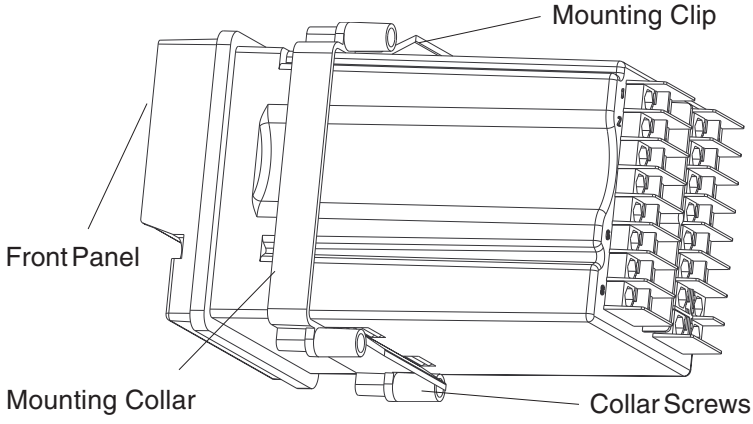


Figure 3.2
Attaching Mounting Collar

CAUTION !
The enclosure into which the 545 Controller is mounted must be grounded according to CSA standard C22.2 No. 0.4.

WARNING!
Avoid electrical shock. Do not connect AC power wiring at the source distribution panel until all wiring connections are complete.

6. Insert the four mounting collar screws from the rear of the collar. Gradually tighten the screws (using a Phillips #2 screwdriver) to secure the controller against the panel.
7. If there is difficulty with any of the mounting requirements, apply a bead of caulk or silicone sealant behind the panel around the perimeter of the case.

WIRING

Our 545 controllers are thoroughly tested, calibrated and "burned in" at the factory, so the controller is ready to install. Before beginning, read this chapter thoroughly and take great care in planning a system. A properly designed system can help prevent problems such as electrical noise disturbances and dangerous extreme conditions.

1. For improved electrical noise immunity, install the 545 as far away as possible from motors, relays and other similar noise generators.
2. Do not run low power (sensor input) lines in the same bundle as AC power lines. Grouping these lines in the same bundle can create electrical noise interference.
3. All wiring and fusing should conform to the National Electric Code and to any locally applicable codes.
4. An excellent resource about good wiring practices is the IEEE Standard No. 518-1982 and is available from IEEE, Inc., 345 East 47th Street, New York, NY 10017, (212) 705-7900.

Diagrams on the next three pages serve as guides for wiring different types of process inputs. The shaded areas on the diagrams show which rear terminals are used for that type of wiring.

AC Power Input

TOP (as viewed from back of controller)

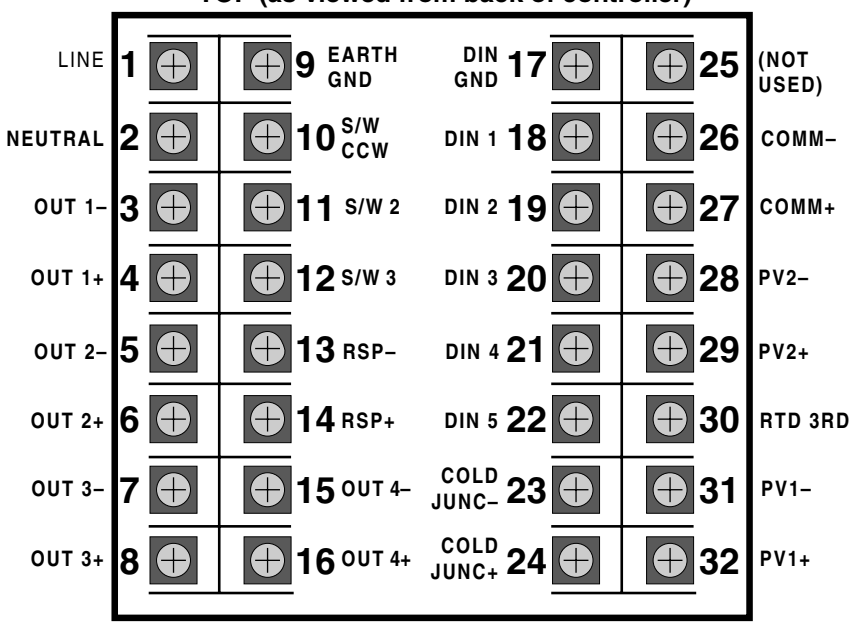


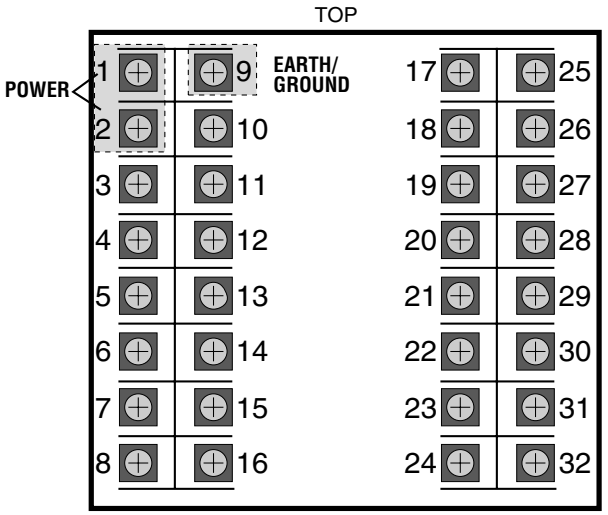
Figure 3.3
Terminal Assignments
Actual 545 device only has top and bottom numbers of each column of terminals marked.

WARNING!
Electric Shock Hazard! Terminals 1 and 2 carry live power. DO NOT touch these terminals when power is on.

WARNING!
Terminal 9 must be grounded to avoid potential shock hazard, and reduced noise immunity to your system.

Terminals 1 and 2 are for **power**. Terminal 9 is the **earth ground**.
Use a 0.5 Amp, 250 V, fast-acting fuse in line with your AC power connection.

Process Variable Input



Screws must be tight to ensure good electrical connection

Figure 3.4
AC Power Input Terminals

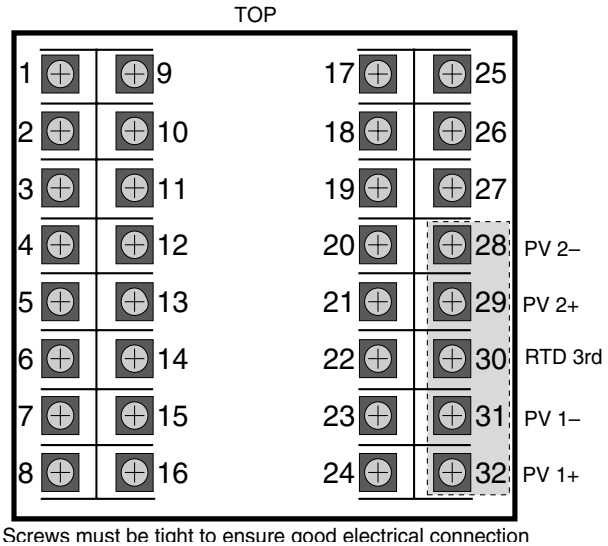
The 545 accommodates the following types of process variable inputs:

- Thermocouple Input
- RTD Input
- Voltage Input
- Milliamp Input with External Power Supply
- Milliamp Input with Internal Power Supply

Each type of input can be wired for PV1 (terminals 31 and 32) or for PV2 (terminals 28 and 29).

CAUTION!
Do not run low power (sensor input) lines in the same bundle as AC power lines. Grouping these lines in the same bundle can create electrical noise interference.

Digital Input(s)

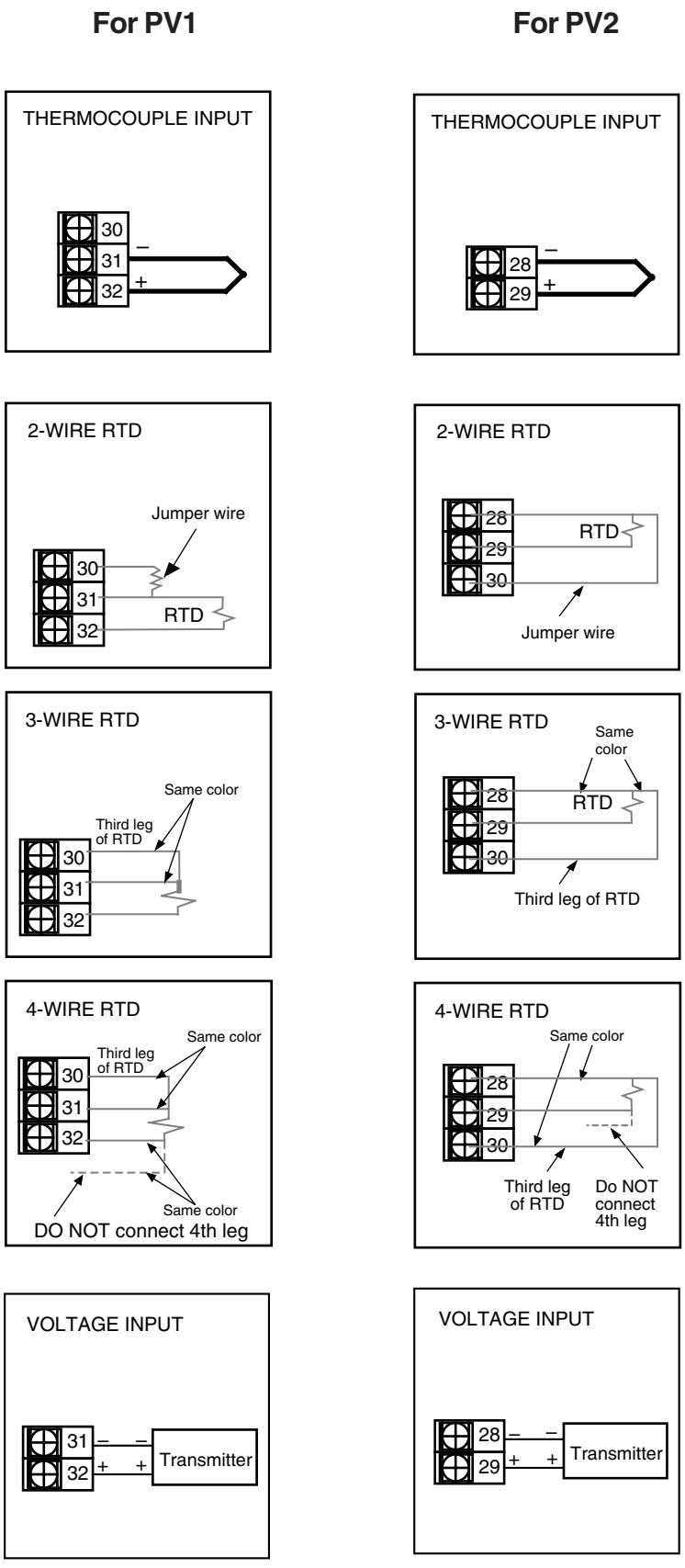


Screws must be tight to ensure good electrical connection

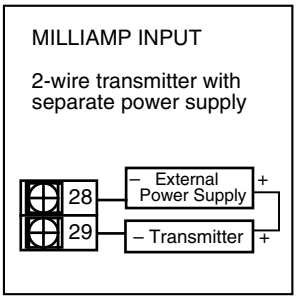
Figure 3.5
Process Variable Terminals

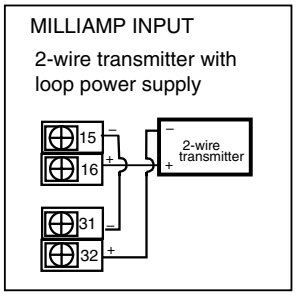
NOTE:
Typically, in the U.S., negative leads are red.

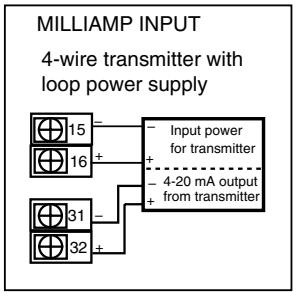
Figure 3.6
PV1 and PV2 Wiring for Milliamp, RTD and Voltage Inputs.



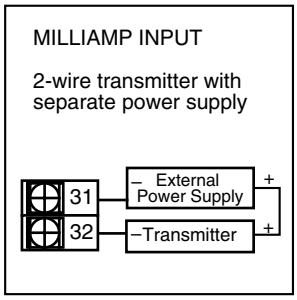
For PV1

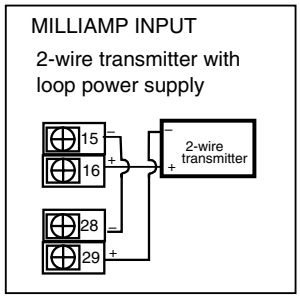






For PV1





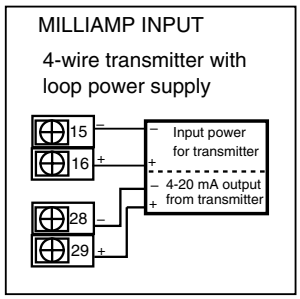


Figure 3.7
PV1 and PV2 Wiring for Milliamp Inputs with Internal and External Power Supply

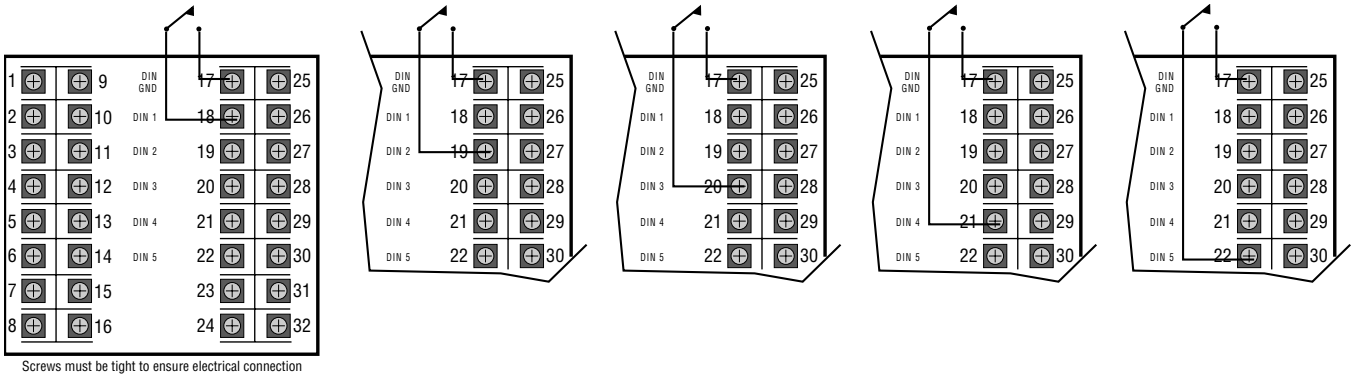
NOTE:
To use loop power, there must be a loop power module is installed in the 3rd or 4th output socket. Compare the controller product number with the order code in Chapter 1 to determine if the 545 has a loop power module installed. To install a loop power module, refer to Chapter 4.

Digital inputs can be activated in three ways: a switch (signal type), closure of a relay, or an open collector transistor. Digital inputs are only functional when that option is installed (via hardware). The controller detects the hardware and supplies the appropriate software menu.

1. Digital Inputs with a switch or relay

Wire the switch/relay between terminal 17 and the specific digital input terminal (Figure 3.8).

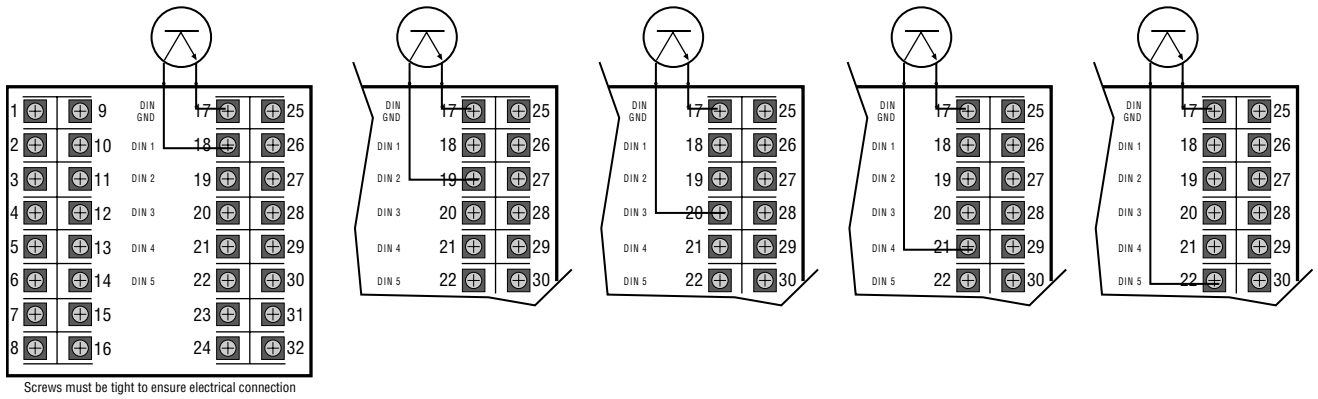
Figure 3.8
Digital Input Wiring with a Switch or Relay


1 9 DIN GND 17 25
2 10 DIN 1 18 26
3 11 DIN 2 19 27
4 12 DIN 3 20 28
5 13 DIN 4 21 29
6 14 DIN 5 22 30
7 15 23 31
8 16 24 32
Screws must be tight to ensure electrical connection

2. Digital Inputs with an Open Collector

An open collector is also called a transistor. Wire the transistor between terminal 17 and the specified digital input terminal (Figure 3.9)

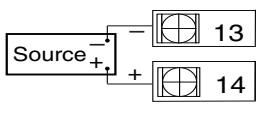
Figure 3.9
Digital Input Wiring with an Open Collector


1 9 DIN GND 17 25
2 10 DIN 1 18 26
3 11 DIN 2 19 27
4 12 DIN 3 20 28
5 13 DIN 4 21 29
6 14 DIN 5 22 30
7 15 23 31
8 16 24 32
Screws must be tight to ensure electrical connection

Remote Setpoint Option

Use terminals 13 and 14 to connect the remote setpoint signal.

Figure 3.10
Remote Setpoint Terminals



OUTPUT MODULES

The 545 output modules are used for control, alarms and retransmission. The four output module types are: **Mechanical** Relay, **Solid State** Relay (Triac), **DC Logic** (SSR Drive) and **Analog** (Milliamp).

To install these modules, plug them into any of the four output sockets on the printed circuit boards (refer to Chapter 4). The wiring is the same whether the modules are used for control, alarm or retransmission.

The diagrams on the next two pages are a guide for properly connecting the various outputs. To find out which module(s) have been installed in the controller, compare the product number on the controller label with the section Order Code in Chapter 1. This section also includes a diagram of how to wire a position proportioning output, a special application using two mechanical or two solid state relays.

NOTE:
Refer to Figure 4.2 for location of the corresponding jumpers.
Second input jumper connector on the option board must be in either *mA* (milliamp) or *V* (voltage) position.

1. Mechanical Relay Output

- Output 1 is always Control 1.
- Outputs 1, 2 and 3 are jumper selectable for normally open and normally closed on the power supply circuit board.
- Output 4 is always configured for normally open and has reduced voltage and current ratings (see Specifications).

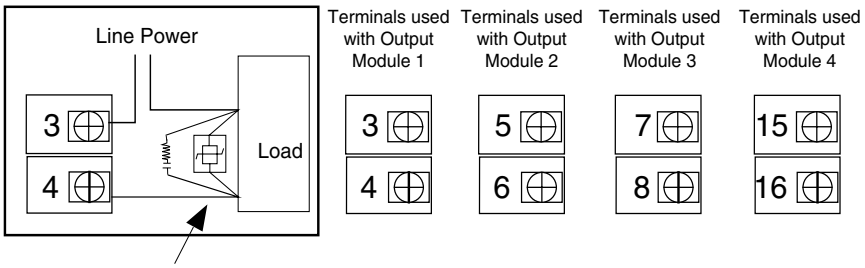


Figure 3.11
Mechanical Relay Output Wiring

2. Solid State Relay (Triac) Output

- Output 1 is always Control 1.
- Respective jumper J1, J2 or J3 must be set to normally open for SSR (Triac) output.
- Output 4 is always configured for normally open and has reduced voltage and current ratings (see Specifications).

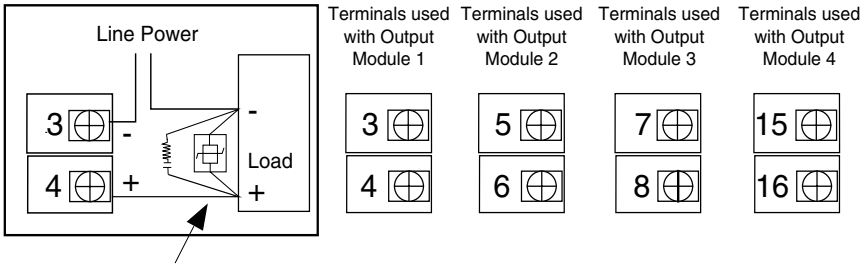
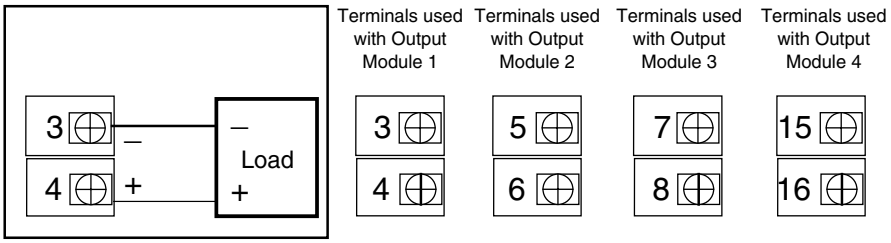


Figure 3.12
SSR Relay Output Wiring

3. DC Logic (SSR Drive) Output

- Output 1 is always Control 1.
- Respective jumper J1, J2 or J3 must be set to normally open for DC Logic output.
- Output 4 is always configured for normally open.

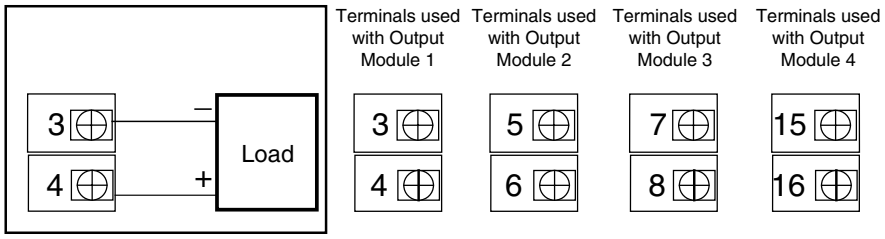
Figure 3.13
DC Logic Output Wiring



4. Milliamp Output

- Output 1 is always Control 1.
- Respective jumper J1, J2 or J3 must be set to normally open for Milliamp output.

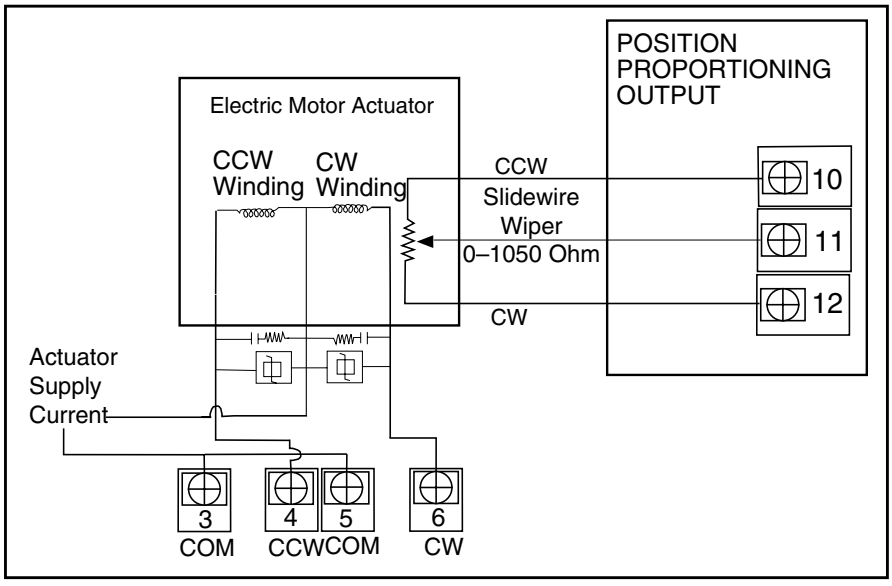
Figure 3.14
Milliamp Output Wiring



5. Position Proportioning Output

(with or without Slidewire Feedback)

Figure 3.15
Position Proportioning Output Wiring

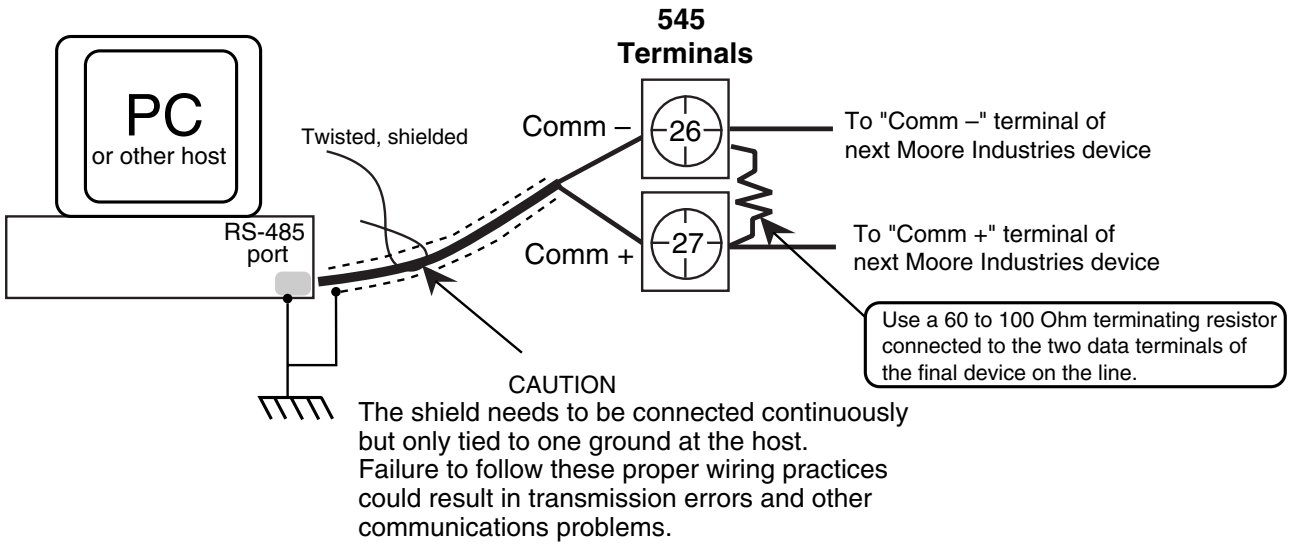


- Mechanical relay or solid state relay modules must be installed in output sockets 1 and 2.
- When using velocity control (no slidewire feedback), there are no connections at terminals 10, 11 and 12.
- Use of the slidewire feedback is optional

Serial Communications

A twisted shielded pair of wires should be used to interconnect the host and field units. Belden #9414 foil shield or #8441 braid shield 22-gauge wire are acceptable for most applications. The foil shielded wire has superior noise rejection characteristics. The braid shielded wire has more flexibility. The maximum recommended length of the RS 485 line is 4000 feet. Termination resistors are required at the host and the last device on the line. Some RS 485 cards/converters already have a terminating resistor. We recommend using RS-232/RS-485 converter (Product #500-485). The communication protocol is asynchronous bidirectional half-duplex, hence the leads are labelled *Comm +* and *Comm –*.

Figure 3.16
Serial Communications Terminals



Installation

CHAPTER 4
HARDWARE CONFIGURATION

Hardware configuration determines the available outputs as well as the type of input signal. The 545 controller comes factory set with the following:

- All specified module and options installed (for details, refer to the Order Code in Chapter 1).
- Process variable and remote setpoint set to accept a milliamp input.
- Relay outputs set to normally open.

Alter the factory configuration of the 545, requires accessing the circuit boards, and locating the jumpers and output modules (see Figure 4.1).

1. With the power off, loosen the four front screws, and remove them.
2. Slide chassis out of the case by pulling firmly on the bezel.

NOTE:
Hardware configuration of the controller is available at the factory; Consult an application engineer for details.

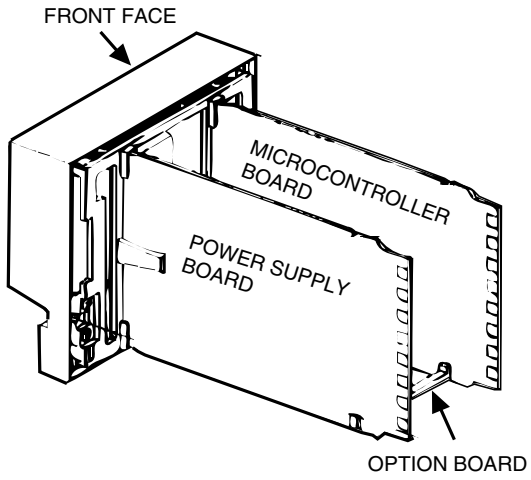


Figure 4.1
Location of Printed Circuit Boards for Hardware Configuration

A detailed view of the circuit boards appears in Figure 4.2.

After configuring the hardware, or if no changes are necessary, continue setting up the process as needed.

HARDWARE INPUT TYPES

The Process Variable

The 545 accepts several different types of process variable signals. Set a jumper location to specify the type of input signal. Set the signal range in the software (see Chapter 5 for software menus, or Chapter 7 for applications).

The jumpers for the process variable are located on the Microcontroller Circuit Board (see Figure 4.2). The factory default is Milliamp. Locations are marked as follows:

V	Voltage
MA	Milliamp
TC ▼	Thermocouple with downscale burnout
TC ▲	Thermocouple with upscale burnout
RTD	RTD

NOTE:
Thermocouple downscale and upscale burnout offers a choice in which direction the controller would react in the event of thermocouple failure. For example, in heat applications, typically, it is desirable to fail upscale (TC ▲) so that the system does not apply more heat.

NOTE:
Changing the jumpers means moving the jumper connector. The jumper connector slips over the pins, straddling two rows of pins. The printed circuit boards are labeled next to the jumpers.

The Remote Setpoint

Figure 4.2 shows the location of the remote setpoint jumper. **The factory default is milliamp**. Choose from the following settings:

V Remote setpoint with voltage signal (jumper removed)

mA Remote setpoint with milliamp signal (jumper installed)

Mechanical Relays

There are three output module sockets on the Power Supply Circuit Board, and one output module on the Option Board (see Figure 4.2). The mechanical relay on the Power Supply Board may be configured for either normally open (NO) or normally closed (NC). A jumper located next to each socket determines this configuration. All relay output are factory set to NO (normally open).

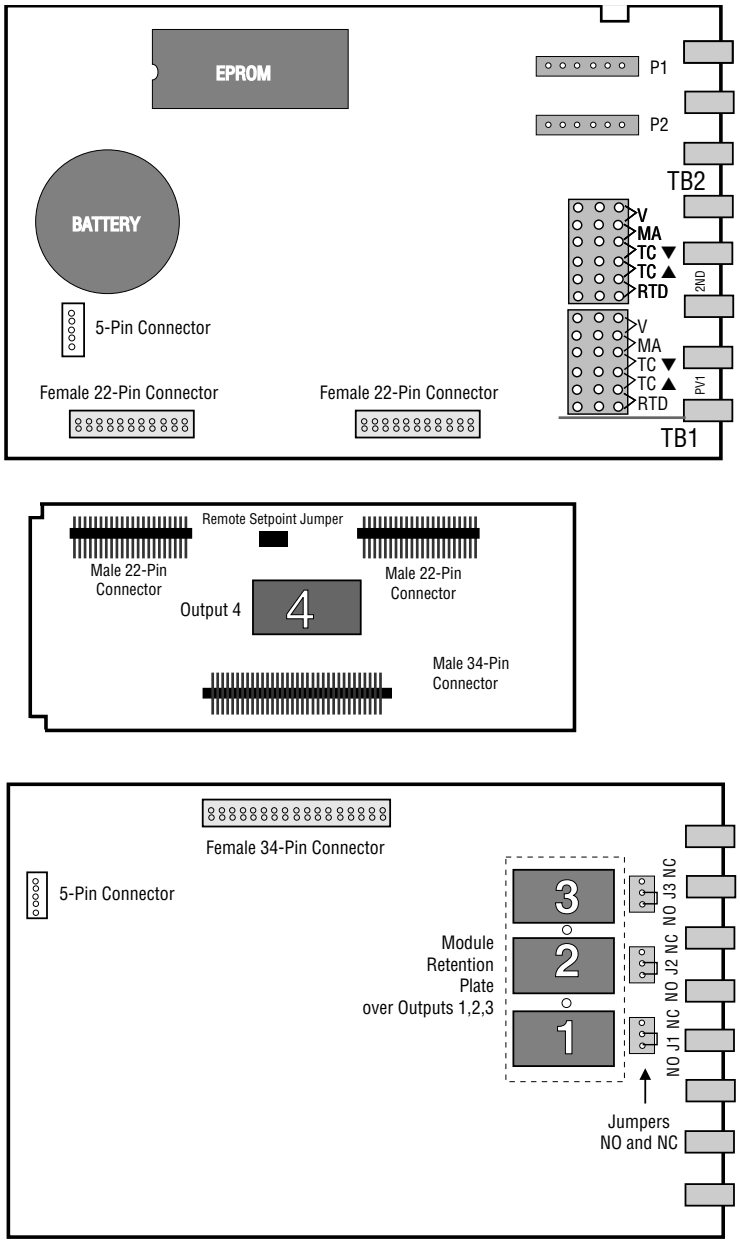


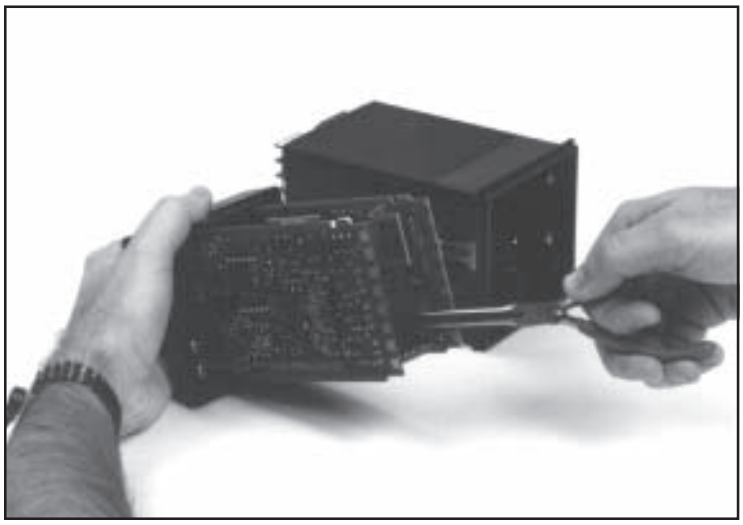
Figure 4.2
(from the top) The Microcontroller Circuit Board, the Option Board, and the Power Supply Board

ACCESSING AND CHANGING JUMPERS

Follow these instructions to change jumpers for the Process Variable, Remote Setpoint and Digital Inputs:

Equipment needed: Needle-nose pliers (optional)
Phillips screwdriver (#2)
Wrist grounding strap

1. With power off, loosen two front screws, and remove them.
2. Side the chassis out of the case by pulling firmly on the bezel.
3. Use Figure 4.2 to locate the jumper connector to change.
4. Using the needle nose pliers (or fingers), pull straight up on the connector and remove it from its pins, as shown in Photo 2. Be careful not to bend the pins.



2. Remove Jumpers

5. Find the new location of the jumper connector (again, refer to Figure 3.2). Carefully place it over the pins, then press connector straight down. Make sure it is seated firmly on the pins.
6. Make any other jumper changes as needed. **To alter output modules 1, please refer to the next section, starting with Step #3.**
7. To reassemble the controller, properly orient the chassis with board opening on top. Align the circuit boards into the grooves on the top and bottom of the case. Press firmly on the front face assembly until the chassis is all the way into the case.

   If it is difficult to slide the chassis in all the way, make sure the screws have been removed (they can block proper alignment), and that the chassis is properly oriented.
8. Carefully insert and align screws. Tighten them until the bezel is seated firmly against the gasket. **Do not overtighten.**

Caution!!
Static discharge can cause damage to equipment. Always use a wrist grounding strap when handling electronics to prevent static discharge.

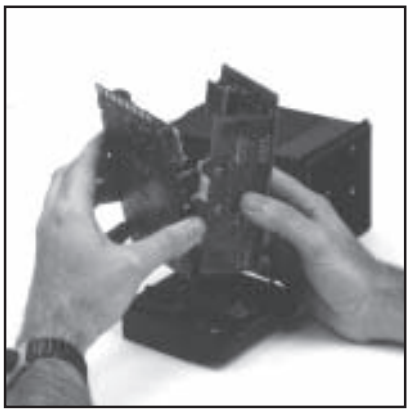
ADDING AND CHANGING OUTPUT MODULES

The 545 has provisions for four output modules. A controller ordered with output module options already has the modules properly installed. Follow these instructions to add modules, change module type(s) or change module location(s).

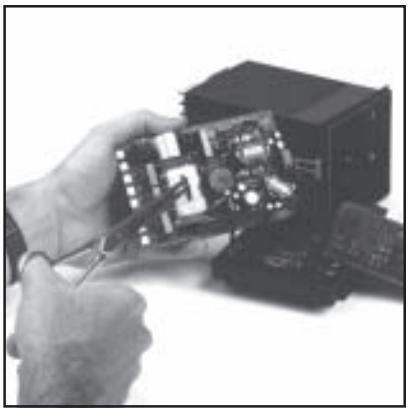
Equipment needed: Wrist grounding strap
Phillips screwdriver (#2)
Small flat blade screwdriver
Wire cutters

1. With power off, loosen two front screws, and remove them.
2. Slide the chassis out of the case by pulling firmly on the bezel.
3. Use a flat screwdriver to carefully pry apart the clips that hold the front face assembly to the chassis, as in Photo 3. Separate the printed circuit board assembly from the front face assembly. Use care not to break the clips or scratch the circuit boards.
4. As shown in Photo 4, carefully pry apart, using hands or a small flat screwdriver, the smaller Option board and the Power Supply board (the one with 3 modules).
5. **To change modules 1, 2 or 3:**
   Output modules 1, 2, and 3 are firmly held in place by a retention plate and tie wrap. Carefully snip the tie wrap with a wire cutter. To prevent damage to the surface mount components, ALWAYS snip the tie wrap on TOP of the Retention Plate, as shown in Photo 5.
   Remove the retention plate.

3. Pry Clips



4. Separate Boards



5. Remove Retention Plate

6. **To change module 4:**
   Output Module 4 (on the Option board) is also held in place by a tie wrap. Snip tie wrap to remove module as shown in Photo 6.
7. Figure 4.3 shows a representation of an output module. Inspect the module(s) to make sure that the pins are straight.
8. To install any module, align its pins with the holes in the circuit board, and carefully insert the module in the socket. Press down on the module until it is firmly seated; refer to Photo 7.

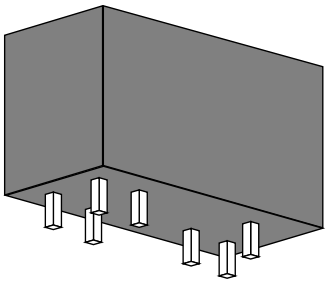
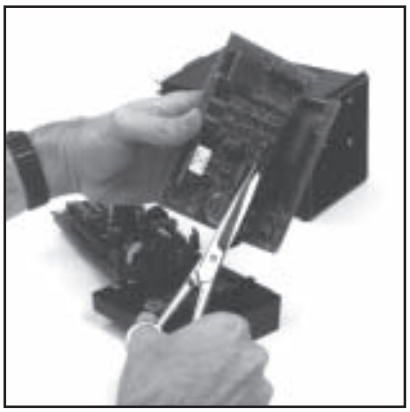
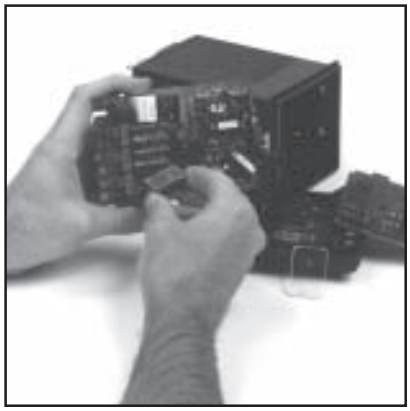


Figure 4.3
Representation of Module



6. Snip Tie Wrap



7. Add/Change Module

9. Replace tie wraps for <u>all</u> the modules (the Retention Plate and Output Module 4) with new ones before reassembling the controller.
   Failure to use the tie wraps may result in loosening of the module and eventual failure. All separately ordered modules should come with a tie wrap. Extra sets of tie wraps are available by ordering Part #545-665.
   NOTE: For greatest accuracy, calibrate all milliamp modules added for retransmission as per the instructions in Appendix 2.
10. Rejoin the circuit boards by aligning the pins of their connectors, then squeezing the board(s) together. Make sure that all three printed circuit boards are properly seated against one another; check along side edges for gaps. Make sure the cable assemblies are not pinched.
11. To reattach the board assembly to the front face assembly, align the boards (with the open area on top) into the slots of the font face assembly. The clips should snap into place.
12. To reassemble the controller, properly orient the chassis with board opening on top. Align the circuit boards into the grooves on the top and bottom of the case. Press firmly on the front face assembly until the chassis is all the way into the case.
    If it is difficult to slide the chassis in all the way, make sure the screws have been removed (they can block proper alignment), and that the chassis is properly oriented.
13. Carefully insert and align screws. Tighten them until the bezel is seated firmly against the gasket. **Do not overtighten.**

SPECIAL COMMUNICATIONS MODULE

A special communications module is available for the 545; see order code in Chapter 1 for details.

Equipment needed: Wrist grounding strap
Phillips screwdriver (#2)
Small flat blade screwdriver

1. Before installing the communications module, set up the hardware wiring for the application. See Chapter 4 for details.
2. With power off, loosen two front screws, and remove them.
3. Slide the chassis out of the case by pulling firmly on the bezel. Do not detach the board assembly from the front face of the controller.
4. Orient the Communications Module as shown, and attach it to Connectors P1 and P2 as shown in Figure 4.4.

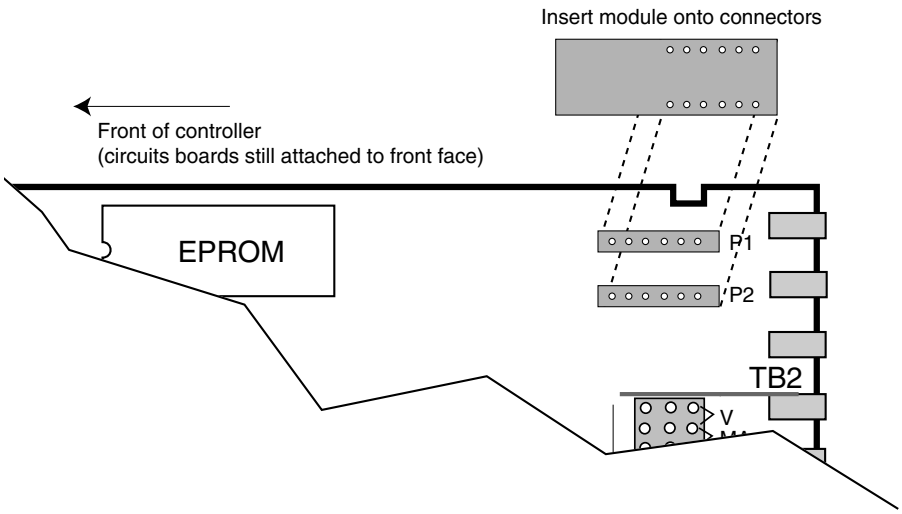


Figure 4.4
Install Communications Module onto Microcontroller Board

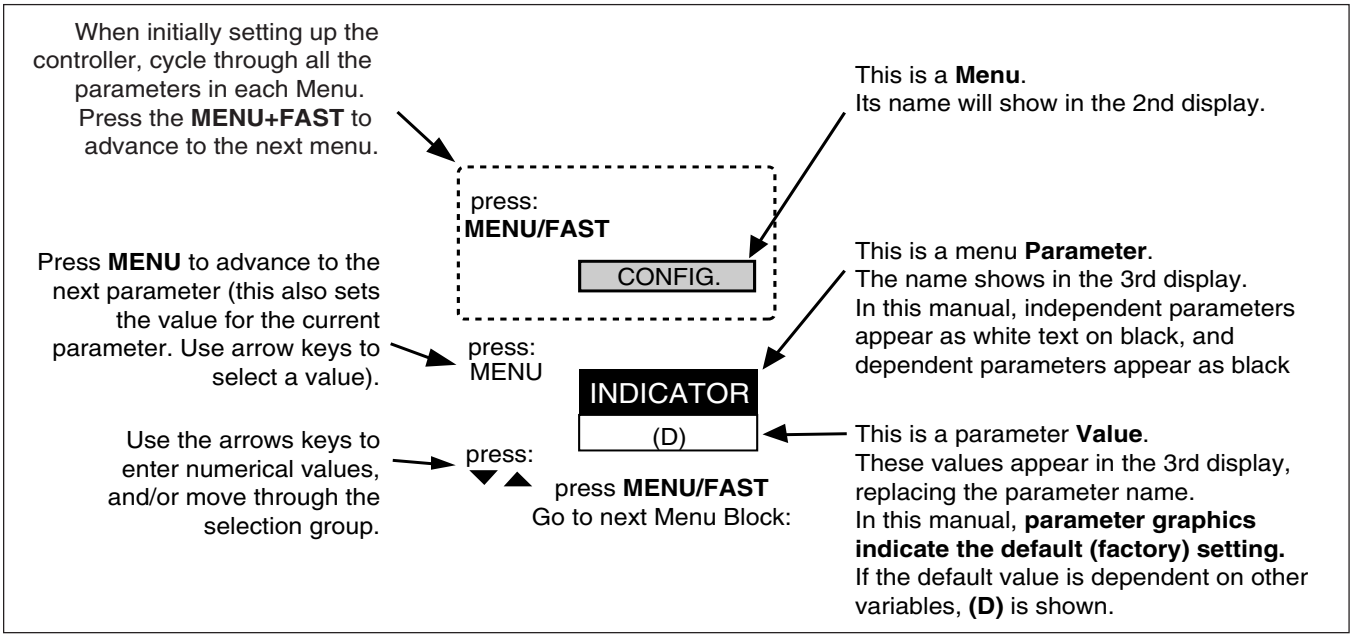
5. To reassemble the controller, properly orient the chassis with board opening on top. Align the circuit boards into the grooves on the top and bottom of the case. Press firmly on the front face assembly until the chassis is all the way into the case.

   If it is difficult to slide the chassis in all the way, make sure the screws have been removed (they can block proper alignment), and that the chassis is properly oriented.
6. Carefully insert and align screws. Tighten them until the bezel is seated firmly against the gasket. **Do not overtighten.**

CHAPTER 5
SOFTWARE CONFIGURATION

The software configuration menus of the 545 contain user-selected variables that define the action of the controller. Read through this section before making any parameter adjustments to the controller.

Figure 5.1
Parts of the Menu Block


When initially setting up the controller, cycle through all the parameters in each Menu. Press the **MENU+FAST** to advance to the next menu.
press:
MENU/FAST
CONFIG.
This is a **Menu**.
Its name will show in the 2nd display.
Press **MENU** to advance to the next parameter (this also sets the value for the current parameter. Use arrow keys to select a value).
press:
MENU
INDICATOR
(D)
This is a menu **Parameter**.
The name shows in the 3rd display.
In this manual, independent parameters appear as white text on black, and dependent parameters appear as black
Use the arrows keys to enter numerical values, and/or move through the selection group.
press:
press **MENU/FAST**
Go to next Menu Block:
This is a parameter **Value**.
These values appear in the 3rd display, replacing the parameter name.
In this manual, **parameter graphics indicate the default (factory) setting.**
If the default value is dependent on other variables, **(D)** is shown.

MENUS

In **SETUP** mode, there are 12 sets of options that control different aspects of 545 operation; in **TUNING** mode, there is one. Each set of options is called a **menu**. When traversing the two modes, the menu names appear in the 2nd display.

Most of the menus are loop dependent, that is, each loop has its own set of parameters for that menu. Three of the menus are global, that is, one set of parameters applies to both loops.

CONFIG	(Global) Mode selection and input/output hardware assignments
PV INPUT	Process variable input options
CUST. LINR.	Linearization curve options for PV input.
CONTROL	Control options
ALARMS	Alarm options
REM. SETPT.	(Global) Controller remote setpoint options
RETRANS.	(Global) Retransmission output options
SELF TUNE	Self tune algorithm options
SPECIAL	Special feature options
SECURITY	(Global) Security functions
SER.COMM.	(Global) Serial Communications options (requires comm. board)

and

TUNING	Tuning parameters configuration (see Chapter 6)

CAUTION!
All software changes occur in real time; always perform set up functions under manual operation.

NOTE:
For information about the Tuning menu/mode, refer to Chapter 6. For more information about set up parameters and 545 applications, refer to Chapter 7.

TUNE PT.
AUTOMATIC

CONTACT 1
MANUAL

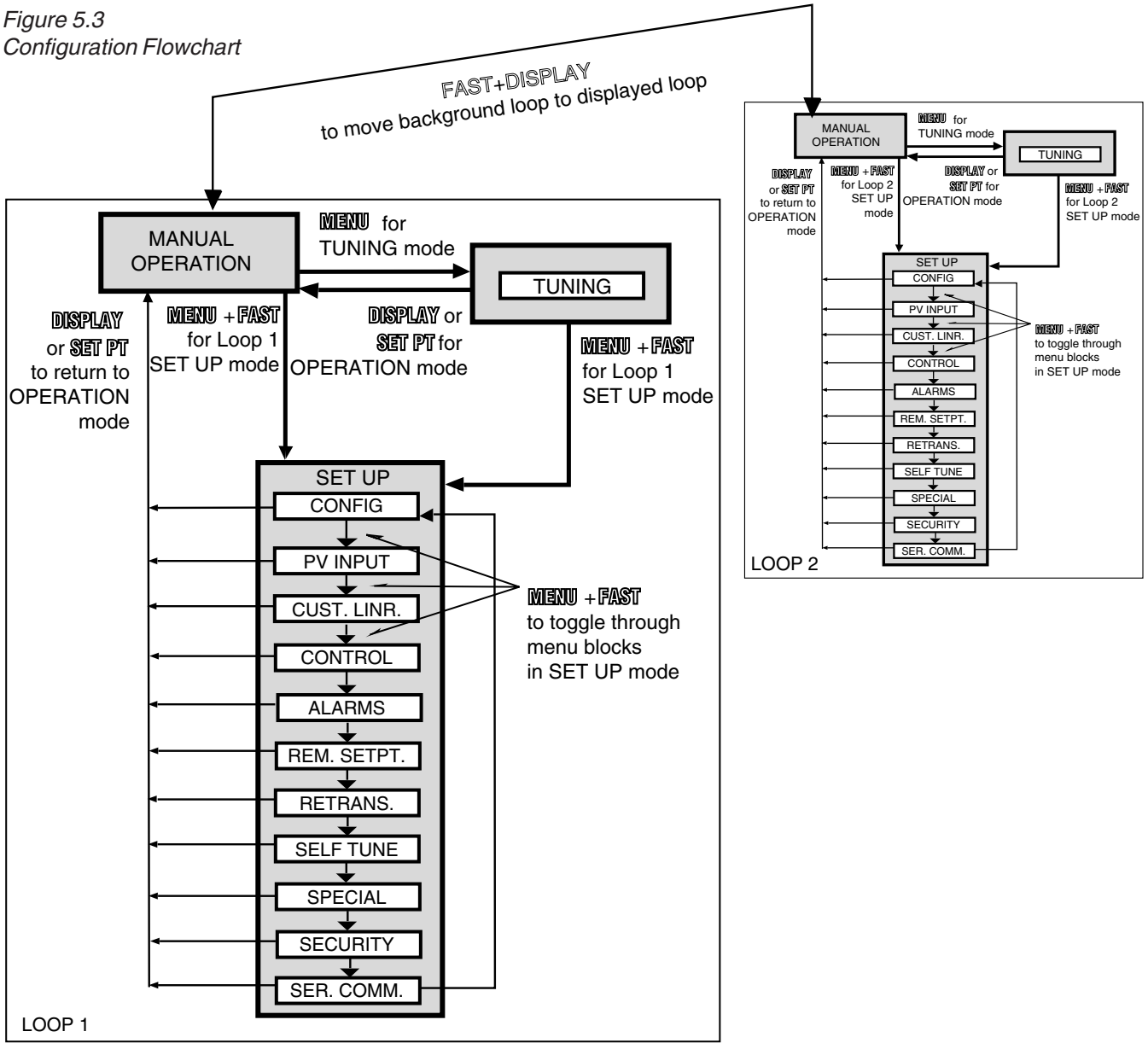
Figure 5.2
Independent vs. Depedent Parameters

PARAMETERS

Within each menu are **parameters** for particular control functions. Select values for each parameter depending on the specific application. Use the MENU key to access parameters for a particular menu; the parameter name will replace the menu name in the 2nd display, and the parameter value will show in the 3rd display.

This chapter outlines **all** the available parameters for the 545. Some parameters are **independent** of any special configuration, and others are **dependent** on the individual configuration. This manual displays these two types of parameters differently; refer to Figure 5.2. A special feature of the 545, called **Smart Menus**, determines the correct parameters to display for the specific configuration, so not all the listed parameters will appear.

Figure 5.3
Configuration Flowchart

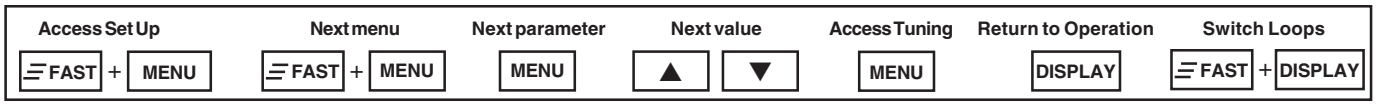


CONFIGURATION AND OPERATION

Figure 5.3 shows the relationships among the different modes of the 545 and the configuration menus:

- Parameter changes can only be made to the loop in the foreground (Loop 1 upon power up). To bring the background loop into the foreground to view and make changes, hold down **FAST and press DISPLAY**.
- **SET UP** menus can only be accessed from manual control. To transfer the 545 from automatic to manual control, press **MANUAL**.
- To access the **SET UP** menus, hold down **FAST and press MENU**. The **MENU** key will illuminate; and CONFIG will appear in the 2nd display.
- To access the parameters for a particular menu, press **MENU**.
- To select a parameter value, use ▲ and ▼. Press **MENU** to advance to the next parameter, or **FAST+MENU** to advance to the next menu.
- To advance to the next menu, press **FAST+MENU**.
- **TUNING** mode (and the **TUNING** menu) can be accessed from either automatic or manual control. To access the tuning menu, press **MENU** .
- To return controller to manual control, press **DISPLAY** or **SET PT**.

A key to these functions (as shown below) appears at the bottom of every page in the menu section of this chapter.



WHERE TO GO NEXT

- For information about all the software menus and parameters, continue reading this chapter. Refer to Appendix 1 for a quick-reference flowchart of all menus and parameters.
- For information about the installed options on the 545, compare the product label on top of the controller to the order code in Chapter 1.
- To mount the controller and configure the wiring of the 545 for inputs and outputs, see Chapter 3.
- To alter the output module and jumper configuration, see Chapter 4.
- For more information about the Tuning function of the 545, see Chapter 6.
- For more information about application for the 545, see Chapter 7.

TEXT FORMATTING IN THIS MANUAL

Feature	**Format**
KEYS	**SET PT** **DISPLAY**
	or
	SETPT DISPLAY
ICONS	OUT, ALM
MENUS	CONFIG., TUNING,
PARAMETERS	CYCLE TM:1, MIN.OUT2
PARAMETER VALUES	OFF, SETPOINT, LAST OUT.
DISPLAY MESSAGES	TOO HOT, OUT%

STEP-BY-STEP GUIDE TO SETUP PARAMETERS

CONFIG.

CONFIG.

For configuring the input and output hardware assignments. (GLOBAL)

CTRL.TYPE
ONE LOOP

1. CTRL. TYPE

Defines the fundamental controller setup.

D	ONE LOOP	Single PV, Single Control Output
•	DUAL LOOP	Two PV, with Control Output for each
•	RATIO	Two loops with Set Points rationed
•	CASCADE	Two PV with single Control Output
•	FFWD.SUM	Single loop control, 2nd PV added to or subtracted from output value
•	FFWD.MULT	Single loop control, 2nd PV multiplies output value

LOOP1 OUT
STANDARD

2. LOOP1 OUT

Defines standard configuration for Loop 1.

D	STANDARD	Standard control output
•	DUPLEX	Duplex outputs (Refer to Chapter 7)
•	STAGED	Staged outputs (Refer to Chapter 7)
•	POS.PROP.	Position proportioning control output

LOOP2 OUT
STANDARD

3. LOOP2 OUT

Defines standard configuration for Loop 2.

D	STANDARD	Standard control output
•	DUPLEX	Duplex outputs (Refer to Chapter 7)
•	STAGED	Staged outputs (Refer to Chapter 7)
•	POS.PROP.	Position proportioning control output
•	NONE	Allows second loop to function as an indicator

LINE FREQ.
60 HZ

4. LINE FREQ

Specifies the power source frequency

D 60 Hz
• 50 Hz

OUTPUT:2
OFF

5. OUTPUT:2

Defines the function of the second output.

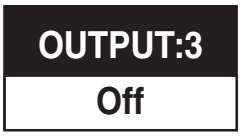
D	OFF	Completely deactivates output
•	ALM.RLY:ON	
•	ALM.RLY:OFF	
•	RETRANS.	Retransmission
•	COMM. ONLY	Output addressable only through communications

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

6. OUTPUT:3

Defines the function of the third output.

D	OFF	Completely deactivates output
•	ALM.RLY:ON	
•	ALM.RLY:OFF	
•	RETRANS.	Retransmission
•	COMM. ONLY	Output addressable only through communications



7. OUTPUT:4

Defines the function of the fourth output.

D	OFF	Completely deactivates output
•	ALM.RLY:ON	
•	ALM.RLY:OFF	
•	RETRANS.	Retransmission
•	COMM. ONLY	Output addressable only through communications

8. ANLG. RNG.:1

Defines the output signal for the first output.

D 4–20mA
- 0–20mA
- 20-4mA
- 20-0mA

9. ANLG. RNG.:2

Defines the output signal for the second output.

D 4–20mA
- 0–20mA
- 20-4mA
- 20-0mA

10. ANLG. RNG.:3

Defines the output signal for the third output.

D 4–20mA
- 0–20mA
- 20-4mA
- 20-0mA

11. ANLG. RNG.:4

Defines the output signal for the fourth output.

D 4–20mA
- 0–20mA
- 20-4mA
- 20-0mA

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

CONTACT 1
L1.MAN

12. CONTACT 1

Defines the operation of the **first digital input, for Loop 1**.

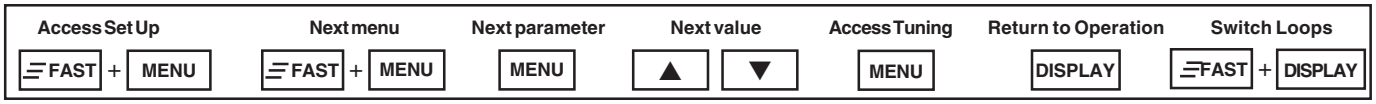
D	L1. MAN.	Trips the controller to manual control
•	L1.2ND. SP.	Makes the second setpoint active
•	L1. 2ND. PID.	Makes the second set of PID values active
•	L1. ALARM ACK.	Acknowledges alarms
•	L1. RST. INH.	Deactivates the reset term
•	L1. D.A./R.A.	Switches the control action
•	L1. NO. A/T	Suspends the adaptive tune function
•	L1. LCK. MAN	Locks controller in manual control
•	UP KEY	Remote ▲ function
•	DOWN KEY	Remote ▼ function
•	DISP KEY	Toggle between **SP DEV** or **OUT%**
•	FAST KEY	Actives **FAST** key
•	MENU KEY	Activates **MENU** key
•	COMM. ONLY	Status readable only through communications
•	L1.SP. 1-4	Assigns the first two digital inputs to select setpoints 1 through 4 via BCD signal
•	L1. REM. SP.	Makes the remote setpoint active

CONTACT 2
L1.REM.SP

13. CONTACT 2

Defines the operation of the **second digital input, for Loop 1**.

•	L1. MAN.	Trips the controller to manual control
•	L1.2ND. SP.	Makes the second setpoint active
•	L1. 2ND. PID.	Makes the second set of PID values active
•	L1. ALARM ACK.	Acknowledges alarms
•	L1. RST. INH.	Deactivates the reset term
•	L1. D.A./R.A.	Switches the control action
•	L1. NO. A/T	Suspends the adaptive tune function
•	L1. LCK. MAN	Locks controller in manual control
•	UP KEY	Remote ▲ function
•	DOWN KEY	Remote ▼ function
•	DISP KEY	Toggles between SP DEV or OUT%
•	FAST KEY	Actives FAST key
•	MENU KEY	Activates MENU key
•	COMM. ONLY	Status readable only through communications
D	L1. REM. SP.	Makes the remote setpoint active



14. CONTACT 3

CONTACT 3
L1.2ND.SP

Defines the operation of the **third digital input, for Loop 1.**

•	L1. MAN.	Trips the controller to manual control
D	L1.2ND. SP.	Makes the second setpoint active
•	L1. 2ND. PID.	Makes the second set of PID values active
•	L1. ALARM ACK.	Acknowledges alarms
•	L1. RST. INH.	Deactivates the reset term
•	L1. D.A./R.A.	Switches the control action
•	L1. NO. A/T	Suspends the adaptive tune function
•	L1. LCK. MAN	Locks controller in manual control
•	UP KEY	Remote ▲ function
•	DOWN KEY	Remote ▼ function
•	DISP KEY	Toggle between **SP DEV** or **OUT%**
•	FAST KEY	Actives **FAST** key
•	MENU KEY	Activates **MENU** key
•	COMM. ONLY	Status readable only through communications
•	L1. REM. SP.	Makes the remote setpoint active

15. CONTACT 4

CONTACT 4
L2.MAN.

Defines the operation of the **fourth digital input, for Loop 2**.

D	L2. MAN.	Trips the controller to manual control
•	L2.2ND. SP.	Makes the second setpoint active
•	L2. 2ND. PID.	Makes the second set of PID values active
•	L2. ALARM ACK.	Acknowledges alarms
•	L2. RST. INH.	Deactivates the reset term
•	L2. D.A./R.A.	Switches the control action
•	L2. NO. A/T	Suspends the adaptive tune function
•	L2. LCK. MAN	Locks controller in manual control
•	UP KEY	Remote ▲ function
•	DOWN KEY	Remote ▼ function
•	DISP KEY	Toggles between **SP DEV** or **OUT%**
•	FAST KEY	Actives **FAST** key
•	MENU KEY	Activates **MENU** key
•	COMM. ONLY	Status readable only through communications
•	L2.SP. 1-4	Assigns DIN 4 and 5 to select setpoints 1 through 4 via BCD signal
•	L2. REM. SP.	Makes the remote setpoint active

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

CONTACT 5
L2.REM.SP.

16. CONTACT 5

Defines the operation of the **fifth digital input, for the Loop 2**.

- L2. MAN. Trips the controller to manual control
- L2.2ND. SP. Makes the second setpoint active
- L2. 2ND. PID. Makes the second set of PID values active
- L2. ALARM ACK. Acknowledges alarms
- L2. RST. INH. Deactivates the reset term
- L2. D.A./R.A. Switches the control action
- L2. NO. A/T Suspends the adaptive tune function
- L2. LCK. MAN Locks controller in manual control
- UP KEY Remote ▲ function
- DOWN KEY Remote ▼ function
- DISP KEY Toggle between **SP DEV** or **OUT%**
- FAST KEY Activates **FAST** key
- MENU KEY Activates **MENU** key
- COMM. ONLY Status readable only through communications

D L2. REM. SP. Makes the remote setpoint active

RSP ASSN.
NONE

17. RSP ASSN.

Defines the loop that uses the Remote Set Point.

- LOOP 1

D NONE

- LOOP 2
- BOTH

SLIDEWIRE
NONE

18. SLIDEWIRE

Defines the loop that uses the Slidewire Feedback.

- LOOP 1
- LOOP 2

(D) NONE

NAME L1.
LOOP ONE

19. NAME L1.

A 9-character message associated with Loop 1. The first character of the 3rd display will be flashing. To enter message, press ▲ and ▼ keys to scroll through character set. Press FAST to enter the selection and move to next digit. Press **MENU** to advance to next parameter.

D LOOP ONE.

Access Set Up	Next menu	Next parameter	Next value		Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲	▼	MENU	DISPLAY	FAST + DISPLAY

20. NAME L2.

A 9-character message associated with Loop 2. The first character of the 3rd display will be flashing. To enter message, press ▲ and ▼ keys to scroll through character set. Press **FAST** to enter the selection and move to next digit. Press **MENU** to advance to next parameter.

D LOOP TWO.

NAME L2.
LOOP TWO

PV INPUT

PV INPUT

For configuring the process variable (PV) input.

1. PV TYPE

Selects the particular sensor or input range.

PV TYPE
(D)

T/C	RTD	Voltage	Current (mA)
D J T/C	D DIN RTD	D 1-5 V	D 4-20 mA
• E T/C	• JIS RTD	• 0-5 V	• 0-20 mA
• K T/C	• SAMA RTD	• 0-10 mV	
• B T/C		• 0-30 mV	
• N T/C		• 0-60 mV	
• R T/C		• 0-100 mV	
• S T/C		• +/-25 mV	
• T T/C			
• W T/C			
• W5 T/C			
• PLAT.II T/C			

CAUTION!
Set parameter values in the presented order—dependent parameters are dynamically related and changing values of one can alter the value of another.

For example, if SP LO LIM. is set to 0, and the thermocouple type is changed to B T/C, the SP LO LIM. value will change to 104° (the low limit of a type B thermocouple).

2. DEG. F/C/K

Selects the temperature unit if using a thermocouple or RTD.

DEG. F/C/K
FAHR

D FAHR.
- CELSIUS
- KELVIN

3. DECIMAL

Specifies the decimal point position.

Decimal
XXXXX

D XXXXX
- XXXX.X
- XXX.XX
- XX.XXX
- X.XXXX

4. LINEARIZE

Specifies if the input is to be linearized (automactic for T/C's and RTD's).

LINEARIZE
NONE

D NONE
- SQR. ROOT — Square root linearization is activated.
- CUSTOM — 15-point custom linearization curve is activated.

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

LOW RANGE
(D)

5. LOW RANGE

Specifies the engineering unit value corresponding to the lowest input value, e.g. 4mA.

R –9999 to 99999 Maximum is **HI RANGE**

D Dependent on Input Selection

HI RANGE
(D)

6. HI RANGE

Specifies the engineering unit value corresponding to the highest input value, e.g. 20mA.

R –9999 to 99999 Minimum is **LOW RANGE**

D Dependent on Input Selection.

SP LO LIM.
(D)

7. SP LO LIM.

Defines the lowest setpoint value that can be entered from the front panel only.

R –9999 to 99999 Minimum is **LOW RANGE**, Maximum is **SP HI LIM**

D Dependent on **LOW RANGE**

SP HI LIM.
(D)

8. SP HI LIM.

Defines the highest setpoint value that can be entered from the front panel only.

R –9999 to 99999 Minimum is **SP LO. LIM.**, Maximum is **HI RANGE**

D Dependent on **HI RANGE**

SP RAMP
OFF

9. SP RAMP

Defines the rate of change for setpoint changes.

R 1 to 99999 units/hour

D OFF (Deactives the function)

FILTER
0

10. FILTER

Defines the setting for the low pass input filter.

R 0 to 120 seconds

D 0

PV OFFSET
0

11. PV OFFSET

Defines the offset to the process variable in engineering units.

R –9999 to 99999 units

D 0

PV GAIN
1.000

12. PV GAIN

This defines the gain to the process variable.

R 0.100 to 10.000 units

D 1.000

NOTE

Refer to Chapter 7 for more information on Offset and Gain.

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

13.PV RESTOR.

Defines the control mode when a broken process variable signal is restored.

D LAST MODE

- MANUAL
- AUTOMATIC

CUST. LINR.

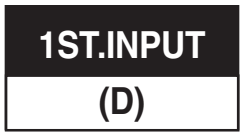
Defines a custom linearization curve for the process variable input. Points 1 and 15 are fixed to the low and high end of the input range, and require only setting a corresponding PV value. Points 2 through 14 (the Xth points) require setting both the input and PV values.

It is not necessary to use all 15 points. Whenever the **XTH INPUT** becomes the high end of the range, that will be the last point in the lineraization table.

1. 1ST. INPUT

Specifies the input signal for to the first point.

D The low end of the appropriate input range (e.g. 4.00mA)

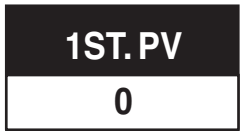


2. 1ST. PV

Specifies the engineering unit value for to the first point.

R –9999 to 99999

D 0

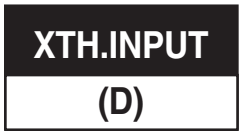


3. XTH. INPUT

Specifies the input signal for to the XTH point (X is 2 to 14) .

R Any value greater than the first input

D The low end of the appropriate input range (e.g. 4.00mA)

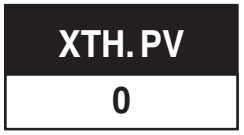


4. XTH. PV

Specifies the engineering unit value for to the XTH point (X is 2 to 14).

R –9999 to 99999

D 0

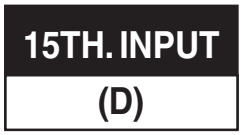


5. 15TH. INPT.

Specifies the input signal for to the 15th point.

R –9999 to 99999

D The high end of the appropriate input range (e.g. 20.00mA)

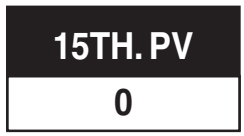


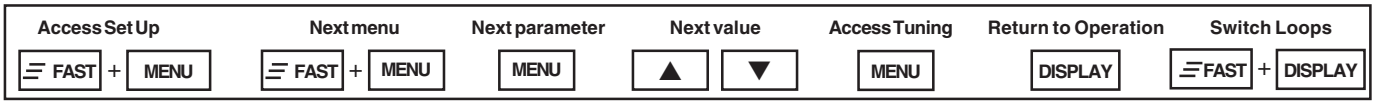
6. 15TH. PV

Specifies the engineering unit value for to the 15th point.

R –9999 to 99999 Minimum is **[XTH-1] INPUT**

D 0





CONTROL

ALGORITHM
PID

D.SOURCE
PV

ACTION:1
REVERSE

FIXED LAG
0

VARBL. LAG
0

MAX. LAG
0

CONTROL

For configuring choices for the control algorithm.

1. ALGORITHM

Defines the control algorithm used.

D PID
- PI
- PD
- P
- ON/OFF
- PID:ON/OFF — For duplex applications using PID for the first output and on/off for the second output

2. D. SOURCE

Selects the variable used to determine the derivative action.

D PV — "D" term will not react when you change the setpoint
- DEVIATION — "D" term will react when you change the setpoint

3. ACTION:1

Defines the action of the first control output.

- DIRECT

D REVERSE

4. FIXED LAG

Defines the fixed amount of lag between control iterations.

R 0 to 14400 seconds
D 0 seconds

5. VARBL. LAG

Defines the variable amound of lag between control iterations.

R 0 to 14400 seconds
D 0 seconds

6. MAX. LAG

Sets the maximum lag time as a result of PV2 action

R 0 to 14400 seconds
D 0 seconds

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

7. PV BREAK

Defines the manual output level if the process variable input is lost.

PV BREAK
(D)

Standard

R -5 to 105 %
D 0

Velocity Prop.

D CW
• CCW
• OUTS.OFF

On/Off

• ON
D OFF

Dual On/Off

• 1:ON, 2:ON
• 1:ON, 2:OFF
• 1:OFF, 2:ON
D 1:OFF, 2:OFF

PID On/Off

R (-5 to 105%), 2:ON
R (-5 to 105%), 2:OFF
D 0%, 2:OFF

Feed Forward Loop 1

R -5 to 105%
• FEED FWD.
D 0%

Feed Forward Loop 2

R -100 to 100%
D 0%

8. LOW OUT.

Defines the lowest output value that can be achieved in automatic control.

LOW OUT.
0%

R 0 – 100% Maximum is **HIGH OUT**
D 0%.

9. HIGH OUT.

Defines the highest output value that can be achieved in automatic control.

HIGH OUT.
100%

R 0 – 100% Minimum is **LOW OUT**
D 100%

10. FF LO LIM.

Defines the low limit for the feed forward output contribution when Loop 2 is in AUTO mode.

FF LO LIM.
-100%

R -100 to 100%
D -100%

11. FF HI LIM.

Defines the high limit for the feed forward output contribution when Loop 2 is in AUTO mode.

FF HI LIM.
100%

R -100 to 100%
D 100%

12. ACTION:2

Defines the action of the second control output.

ACTION:2
DIRECT

D DIRECT
• REVERSE

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

CCW TIME
60

13. CCW TIME

Defines the time it takes a motor to fully stroke counterclockwise.

R 1 to 200 seconds

D 60 seconds

CW TIME
60

14. CW TIME

Defines the time it takes a motor to fully stroke clockwise.

R 1 to 200 seconds

D 60 seconds

MIN. TIME
0.1

15. MIN. TIME

Defines the minimum amount of time the controller must specify for the motor to be on before it takes action.

R 0.1 to 10.0 seconds

D 0.1 seconds

S/W RANGE
100

16. S/W RANGE

Specifies the full range resistance of the slide (e.g., 100 ohms)

R 0–1050 Ohms

D 100 Ohms

OPEN F/B
(D)

17. OPEN F/B

Defines the feedback ohm value corresponding to full open (100% output).

R 0 to **S/W RANGE**

D Dependent upon **S/W RANGE** value

CLOSE F/B
100

18. CLOSE F/B

Defines the feedback ohm value corresponding to full close (0% output).

R 0 to **S/WRANGE**

D 100

OUT1 STOP
50

19. OUT1 STOP

Defines the stopping point for control output 1 when staging outputs.

R 1 to 100%

D 50%

OUT2 STRT.
50

20. OUT2 STRT.

Defines the starting point for control output 2 when staging outputs.

R 0 to 99%

D 50%

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

ALARMS

ALARMS

For configuring alarms.

1. ALM. TYPE:1

ALM.TYPE:1
OFF

Defines the type of alarm for alarm 1.

- HIGH ALRM.
- LOW ALARM
- HIGH/LOW — Separate High and Low alarm setpoints in one alarm
- BAND
- DEVIATION
- MANUAL — Causes an alarm when in manual control
- REMOTE SP — Causes an alarm when in Remote Setpoint
- RATE — Selects a rate-of-change alarm

D OFF — Deactivates the first alarm

2. ALM. SRC:1

ALM. SRC:1
PV

Selects the source of the value being monitored by a HIGH, LOW or HIGH/LOW alarm 1.

D PV
- SP
- RAMP SP
- DEVIATION
- OUTPUT

3. ALARM SP:1

ALARM SP:1
(D)

Specifies the alarm set point for alarm 1.

For HIGH or LOW alarms:

If **ALM.SRC.:1**=OUTPUT	If **ALM.SRC.:1**=any other type
R 0.0% to 100.0%	R **LOW RANGE** to **HI RANGE**
D 0.0%	D 0

For BAND alarms:

R 1 to 99999

D 0

For DEVIATION or RATE alarms:

R -9999 to 99999

D 0

4A. HIGH SP:1

HIGH SP:1
(D)

Specifies the high alarm set point for alarm 1.

If **ALM.SRC.:1**=OUTPUT	If **ALM.SRC.:1**=any other type
R 0.0% to 100.0%	R **LOW RANGE** to **HI RANGE**
D 0.0%	D 0

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

LOW SP:1
(D)

4B. LOW SP:1

Specifies the low alarm setpoint for alarm 1.

If **ALM.SRC.:1**=OUTPUT	If **ALM.SRC.:1**=any other type
R 0.0% to 100.0%	R **LOW RANGE** to **HI RANGE**
D 0.0%	D 0

DEADBAND:1
(D)

5. DEADBAND:1

Defines the deadband for alarm 1.

If **ALM.SRC.:1**=OUTPUT	If **ALM.SRC.:1**=any other type
R 0.1% to 100.0%	R 1 to 9999
D 0.2%	D 2

ALM.:1 OUT.
NONE

6. ALM.:1 OUT.

Selects the output number for alarm 1.

D NONE
- 2
- 3
- 4

LATCHING:1
LATCH

7. LATCHING:1

Defines the latching sequence of alarm 1.

D LATCH
- NO LATCH

ACK.:1
ENABLED

8. ACK.:1

Defines whether alarm 1 may be acknowledged.

D ENABLED	This allows the alarm to be acknowledged
• DISABLED	This prevents the alarm from being acknowledged while in alarm condition

POWER UP:1
NORMAL

9. POWER UP:1

Defines how alarm 1 will be treated on power up.

D NORMAL	Alarm depends on process variable
• ALARM	Always power up in alarm regardless of PV
• DELAYED	Must leave alarm condition and reenter before activating the alarm

MESSAGE:1
ALARM 1

10. MESSAGE:1

A 9-character message associated with alarm 1. The first character of the 3rd display will be flashing. To enter message, press arrow keys to scroll through character set. Press **FAST** key to enter the selection and move to next digit. Press **MENU** key to advance to next parameter.

D ALARM 1

Access Set Up	Next menu	Next parameter	Next value		Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲	▼	MENU	DISPLAY	FAST + DISPLAY

11. ALM. TYPE:2

ALM.TYPE:2
OFF

Defines the type of alarm for alarm 2.

- HIGH ALRM.
- LOW ALARM
- HIGH/LOW — Separate High and Low alarm setpoints in one alarm
- BAND
- DEVIATION
- MANUAL — Causes an alarm when in manual control
- REMOTE SP — Causes an alarm when in Remote Setpoint
- RATE — Selects a rate-of-change alarm

D OFF — Deactivates the first alarm

12. ALM. SRC:2

ALM.SRC:2
PV

Selects the source of the value being monitored by a HIGH, LOW or HIGH/LOW alarm 2.

D PV

- SP
- RAMP SP
- DEVIATION
- OUTPUT

13. ALARM SP:2

ALARM SP:2
(D)

Specifies the alarm setpoint for alarm 2.

For HIGH or LOW alarms:

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.0% to 100.0%	R **LOW RANGE to HI RANGE**
D 0.0%	D 0

For BAND alarms:

R 1 to 99999

D 0

For **DEVIATION** or **RATE** alarms:

R -9999 to 99999

D 0

14A. HIGH SP:2

HIGH SP:2
(D)

Specifies the high alarm setpoint for alarm 1.

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.0% to 100.0%	R LOW RANGE to HI RANGE
D 0.0%	D 0

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

LOW SP:2
(D)

14B. LOW SP:2

Specifies the low alarm set point for alarm 2.

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.0% to 100.0%	R **LOW RANGE to HI RANGE**
D 0.0%	D 0

DEADBAND:2
2

15. DEADBAND:2

Defines the deadband for alarm 2.

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.1% to 100.0%	R 1 to 9999
D 0.2%	D 2

ALM.:2 OUT.
NONE

16. ALM.:2 OUT.

Selects the output number for alarm 2.

D NONE
- 2
- 3
- 4

LATCHING:2
LATCH

17. LATCHING:2

Defines the latching sequence of alarm 2.

D LATCH
- NO LATCH

ACK.:2
ENABLED

18. ACK.:2

Defines whether alarm 2 may be acknowledged.

D ENABLED	Allows the alarm to be acknowledged
• DISABLED	Prevents alarm acknowledgment while alarm condition exists.

POWER UP:2
NORMAL

19. POWER UP:2

Defines how alarm 2 will be treated on power up.

D NORMAL	Alarm depends on process variable
• ALARM	Always power up in alarm regardless of PV
• DELAYED	Must leave & reenter alarm condition before activating alarm

MESSAGE:2
ALARM 2

20. MESSAGE:2

A 9-character message associated with alarm 2. The first character of the 3rd display will be flashing. To enter message, press arrow keys to scroll through character set. Press **FAST** key to enter the selection and move to next digit. Press **MENU** key to advance to next parameter.

D ALARM 2

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

21. FAULT

Defines whether either of the alarm relays will trip if a fault condition (lost process variable) is detected.

Only appears if at least one alarm relay is installed.

D OFF
- ALARM 1
- ALARM 2

FAULT
OFF

22. OUTPUT

Defines whether a rate-of-change alarm will be interpreted as a lost or broken process variable (causing a trip to manual output).

- P.V. BREAK

D NO ACTION

OUTPUT
NO ACTION

23. RATE TIME

Defines the time period over which a rate-of-change alarm condition will be determined.

R 1 to 3600 seconds

D 5 seconds

RATE TIME
5

REM. SETPT.

REM. SETPT.

For configuring the remote setpoint. (GLOBAL)

1. TYPE V/mA

Specifies the type of input signal that will be used for remote setpoint.

D 1-5/4-20 Volts, mA
- 0-5/0-20 Volts, mA

TYPE V/MA
1-5/4-20

2. RSP:LO RNG.

Specifies the engineering unit value corresponding to the lowest remote setpoint input value, e.g. 4mA.

R -9999 to 99999

D 0

RSP:LO RNG.
0

3. RSP:HI RNG.

Specifies the engineering unit value corresponding to the highest remote setpoint input value, e.g. 20mA.

R –9999 to 99999

D 1000

RSP:HI RNG.
1000

4. TRACKING

Defines whether the local setpoints 1 to 8 will track the remote setpoint.

D NO
- YES

TRACKING
NO

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

BIAS LOW
-1000

5. BIAS LOW

Defines the lowest bias value that may be entered.

R –9999 to 99999 (Maximum is BIAS HIGH)

D –1000

BIAS HIGH
1000

6. BIAS HIGH

Defines the highest bias value that may be entered.

R –9999 to 99999 (Minimum value BIAS LOW)

D 1000

RSP. FIXED
LOCAL

7. RSP FIXED

Defines what happens if remote setpoint is lost while it is active and then is restored.

• REMOTE SP	Returns to remote setpoint when it is restored
D LOCAL	Local SP remains active when remote SP is restored

RETRANS.

RETRANS.

For configuring the retransmission output. (GLOBAL)

TYPE:2
PV1

1. TYPE:2

Defines what is to be retransmitted for output 2.

D PV1	Linearized process variable 1
• SP1	Target setpoint 1
• RAMP SP1	Ramping (actual) setpoint 1
• OUT L1	Control output 1
• PV2	Linearized process variable 2
• SP2	Target setpoint 2
• RAMP SP2	Ramping (actual) setpoint 2
• OUT L2	Control output 2

LO RANGE:2
(D)

2. LO RANGE:2

Defines the low end of the range of output 2 in engineering units.

R –9999 to 99999

D Dependent upon process variable range

HI RANGE:2
(D)

3. HI RANGE:2

Defines the high end of the range of output 2 in engineering units.

R –9999 to 99999

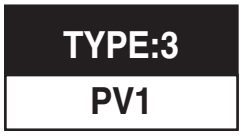
D Dependent on the process variable range

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

4. TYPE:3

Defines what is to be retransmitted for output 3.

D	PV1	Linearized process variable 1
•	SP1	Target setpoint 1
•	RAMP SP1	Ramping (actual) setpoint 1
•	OUT L1	Control output 1
•	PV2	Linearized process variable 2
•	SP2	Target setpoint 2
•	RAMP SP2	Ramping (actual) setpoint 2
•	OUT L2	Control output 2

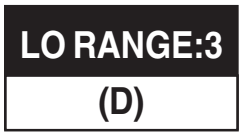


5. LO RANGE:3

Defines the low end of the range for output 3 in engineering units.

R –9999 to 99999

D Dependent upon process variable range

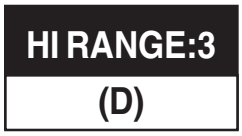


6. HI RANGE:3

Defines the high end of the range for output 3 in engineering units.

R –9999 to 99999

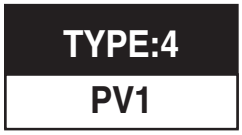
D Dependent on the process variable range



7. TYPE:4

Defines what is to be retransmitted for output 4.

D	PV1	Linearized process variable 1
•	SP1	Target setpoint 1
•	RAMP SP1	Ramping (actual) setpoint 1
•	OUT L1	Control output 1
•	PV2	Linearized process variable 2
•	SP2	Target setpoint 2
•	RAMP SP2	Ramping (actual) setpoint 2
•	OUT L2	Control output 2

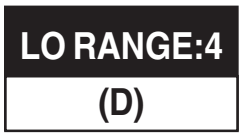


8. LO RANGE:4

Defines the low end of the range for output 4 in engineering units.

R –9999 to 99999

D Dependent upon process variable range

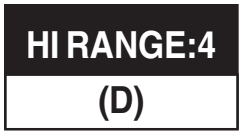


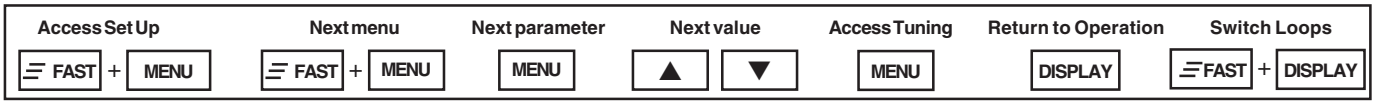
9. HI RANGE:4

Defines the high end of the range for output 4 in engineering units.

R –9999 to 99999

D Dependent on the process variable range





SELFTUNE

SELF TUNE

For configuring the self tune algorithm.

TYPE
DISABLED

1. TYPE

Defines the type of self tuning algorithm that is available.

- PRETUNE — Allows the operator to initiate Pretune only
- ADAPTIVE — Allows the operator to initiate Adaptive Tune only
- BOTH — Allows the operator to initiate both Pretune and Adaptive Tune

D DISABLED — Both Pretune and Adaptive Tune are disabled

PRETUNE
TYPE 1

2. PRETUNE

Defines the type of pretune algorithm that is available.

D TYPE 1 — Normally used with slower thermal processes

- TYPE 2 — Normally used with faster fluid or pressure processes
- TYPE 3 — Normally used with level control applications.

TYPE
AUTOMATIC

3. TUNE PT.

Defines the PV value at which the output with switch off during a **TYPE 1** pretune, which helps prevent overshoot.

D AUTOMATIC — Controller defines this point

- XXX.X — Enter any value within **PV RANGE**

OUT. STEP
10.0

4. OUT. STEP

Defines the output step size in absolute percent during **TYPE 2** or **TYPE 3** pretune.

R -50.0 to 50.0%

D 10.0%

LOW LIMIT
(D)

5. LOW LIMIT

Defines the lower limit the process variable can reach during pretune before aborting.

R The process variable range

D Dependent on the process variable range

HI LIMIT
(D)

6. HI LIMIT

Defines the upper limit the process variable can reach during pretune before aborting.

R The process variable range

D Dependent on the process variable range

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

7. TIMEOUT

Defines the execution time limit for pretune before aborting.

R 8 to 1500 minutes

D 1500 minutes

TIMEOUT
1500

8. MODE

Defines the control mode after pretune is completed.

• MANUAL

D AUTOMATIC

MODE
AUTOMATIC

9. NOISE BND.

Defines the noise band to be used by the adaptive tuning algorithm, as a percentage of the process variable range.

R 0.1 to 10%

D 0.2%

NOISE BND.
0.2

10. RESP. TIME

Defines response time to be used by the adaptive tuning algorithm.

R 10 to 32000 seconds

D 7200 seconds

RESP.TIME
7200

11. DEAD TIME

Defines the amount of time the process runs before controller responds to an output change (POWER BACK feature).

R 0.1 to 7200.0 seconds

D 0.1 seconds

DEAD TIME
0.1

SPECIAL

SPECIAL

For configuring special features.

1. AUTO. TRIP

Defines the condition under which the 545 will automatically trip to automatic control from manual control upon start up.

D OFF	Deactivates this function
• RISING PV	Will trip when a rising process variable is within the specified deviation from the setpoint
• FALLNG. PV	Will trip when a falling process variable is within the specified deviation from the setpoint

AUTO. TRIP
OFF

2. TRIP DEV.

Defines the deviation from setpoint at which the controller trips to automatic.

If **AUTO.TRIP** = RISING PV	If **AUTO.TRIP** = FALLING PV
R -99999 to 0	R 0 to 99999
D 0	D 0

TRIP DEV.
(D)

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

DES.OUT.N
(D)

3. DES.OUT.N (N = 1 to 5)

Designates the output value the corresponding digital input has placed the controller in manual mode. Choose values based on your process.

Standard Control	On/Off Control	Velocity Prop Control
• –5 to 105%	• ON	• CW
D LAST OUT	D OFF	• CCW
		D OUTS. OFF

POWER UP
LAST MODE

4. POWER UP

Defines the control mode upon power up.

D LAST MODE	Power up in the same mode prior to power down
• MANUAL	
• AUTOMATIC	
• PRETUNE	Will Pretune on every power up (recommended for TYPE 1 pretune only).

PWR. UP:OUT
(D)

5. PWR. UP:OUT.

Defines the output of the controller if powering up in manual mode. Choose values based on your process.

Standard Control	On/Off Control	Velocity Prop Control
• –5 to 105%	• ON	• CW
D LAST OUT	D OFF	• CCW
		D OUTS. OFF

PWR. UP:SP
LAST SP

6. PWR. UP:SP

This defines the setpoint upon power up.

D LAST SP	Will power up with the same setpoint (local or remote) that was active prior to power down
• LOCAL	Will power up using primary local setpoint
• REMOTE	Will power up using remote setpoint, if available

NO. OF SP
1

7. NO. OF SP

Defines the number of local setpoints (up to 8) to be stored for selection by the front **SET PT** key or (up to 4) for selection by BCD (Binary Coded Decimal) digital inputs.

R 1 to 8 digits

D 1

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

SECURITY

SECURITY

For configuring the security function. (GLOBAL)

1. SEC. CODE

Defines the security code for temporarily unlocking the instrument.

R –9999 to 99999.

D 0

SEC. CODE
0

2. SP ADJUST

Defines lockout status for setpoint changes.

D UNLOCKED

• LOCKED

SP ADJUST
UNLOCKED

3. AUTO./MAN.

Defines lockout status for **MANUAL** key.

D UNLOCKED

• LOCKED

AUTO./MAN.
UNLOCKED

4. SP SELECT

Defines lockout status for **SET PT** key.

D UNLOCKED

• LOCKED

SP SELECT
UNLOCKED

5. ALARM ACK.

Defines lockout status for **ACK** key.

D UNLOCKED

• LOCKED

ALARM ACK.
UNLOCKED

6. TUNING

Defines lockout status for adjusments to tuning parameters.

D UNLOCKED

• LOCKED

TUNING
UNLOCKED

7. CONFIGURE

Defines lockout status for configuration parameters.

D UNLOCKED

• LOCKED

CONFIGURE
UNLOCKED

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

SER. COMM.

SER. COMM.

For configuring the serial communications features. (GLOBAL)

STATION
1

1. STATION

Defines the unit's station address (one address for both loops in dual loop mode).

R 1 to 99
- OFF (Disables the communications function)

D 1

BAUD RATE
9600

2. BAUD RATE

Defines the baud rate.

- 1200 BPS
- 2400 BPS
- 4800 BPS

D 9600 BPS
- 19200 BPS

CRC
YES

3. CRC

Defines whether CRC (cyclic redundancy check) is being calculated.

D YES
- NO

SHED TIME
OFF

4. SHED TIME

Defines the time interval between communications activity before the controller determines that communications is lost ("sheds").

R 1 to 512 seconds
D OFF

SHED MODE
LAST MODE

5. SHED MODE

Defines the state of the controller if communications is lost ("sheds").

D LAST MODE	The 545 remains in either automatic or manual control
• MANUAL	Trips to manual control
• AUTOMATIC	Trips to automatic control

SHED OUT
(D)

6. SHED OUT.

Defines the output if the unit sheds and trips to manual control. Choose values based on your process.

Standard Control	On/Off Control	Velocity Prop Control
• –5 to 105%	• ON	• CW
D LAST OUT	D OFF	• CCW
		D OUTS. OFF

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

7. SHED SP

Defines the setpoint status if communications is lost.

D	LAST SP	Continues to use the setpoint that was active prior to communications being lost.
•	DESIG. SP	Goes to a designated setpoint value if communications is lost.

8. DESIG. SP

Defines the value of the designated setpoint if communications is lost.

R The process variable range

D Dependent on the process variable range

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

PARAMETER VALUE CHARTS

This section of value charts is provided for logging the actual parameters values and selections for the process. It is recommended that these pages be photocopies so there will always be a master.

CONFIG (Global)

	Parameter	Description	Value
1	**CTRL. TYPE**	Defines fundamental controller Set Up	
2	**LINE FREQ.**	Defines the power source frequency	
3	**LOOP1 OUT**	Defines standard configuration for Loop 1	
4	**LOOP2 OUT**	Defines standard configuration for Loop 2	
5	**OUTPUT:2**	Function of the second output	
6	**OUTPUT:3**	Function of the third output	
7	**OUTPUT:4**	Function of the fourth output	
8	**ANLG.RNG.:1**	Output signal for the first output	
9	**ANLG.RNG.:2**	Output signal for the second output	
10	**ANLG.RNG.:3**	Output signal for the third output	
11	**ANLG.RNG.:4**	Output signal for the fourth output	
12	**CONTACT 1**	Operation of the first digital input for Loop 1	
13	**CONTACT 2**	Operation of the second digital input for Loop 1	
14	**CONTACT 3**	Operation of the third digital input for Loop 1	
15	**CONTACT 4**	Operation of the fourth digital input for Loop 2	
16	**CONTACT 5**	Operation of the fifth digital input for Loop 2	
17	**RSP ASSN.**	Defines which loop uses the Remote Set Point	
18	**SLIDEWIRE**	Defines which loop uses Slidewire Feedback	
19	**NAME L1**	Allows 9 character message to name Loop 1	
20	**NAME L2**	Allows 9 character message to name Loop 2	

PV INPUT

	Parameter	Description	Value Loop 1	Value Loop 2
1	**PV TYPE**	Sensor or range to be used		
2	**DEG. F/C/K**	Temperature engineering unit		
3	**DECIMAL**	Decimal point position		
4	**LINEARIZE**	Type of input linearization		
5	**LOW RANGE**	Engineering unit value for lowerst input value		
6	**HI RANGE**	Engineering unit value for highest input value		
7	**SP LO LIM.**	Lowest setpoint value that can be entered from front panel		
8	**SP HI LIM.**	Highest setpoint value that can be entered from front panel		
9	**SP RAMP**	Rate of change for setpoint changes		
10	**FILTER**	Setting for the low pass input filter		
11	**PV OFFSET**	Offset to the PV in engineering units		
12	**PV GAIN**	Gain to the PV		
13	**PV RESTOR.**	Control mode when a broken PV is restored		

CUST. LINR.

	Parameter	Description	Value Loop 1	Value Loop 2
1	**1st INPUT**	Input signal for the 1st point (of the 15 point curve)		
2	**1st PV**	Engineering unit value for the 1st point		
3	**2nd INPUT**	Input signal for the 2nd point (of the 15 point curve)		
4	**2nd PV**	Engineering unit value for the 2nd point		
5	**Xth INPUT**	Input signal for the Xth (last) point (of the 15 point curve)		
6	**Xth PV**	Engineering unit value for the Xth (last point)		
7	**3rd INPUT**	Input signal for the 3rd point (of the 15 point curve)		
8	**3rd PV**	Engineering unit value for the 3rd point		
9	**4th INPUT**	Input signal for the 4th point (of the 15 point curve)		
10	**4th PV**	Engineering unit value for the 4th point		
11	**5th INPUT**	Input signal for the 5th point (of the 15 point curve)		
12	**5th PV**	Engineering unit value for the 5th point		
13	**6th INPUT**	Input signal for the 6th point (of the 15 point curve)		
14	**6th PV**	Engineering unit value for the 6th point		
15	**7th INPUT**	Input signal for the 7th point (of the 15 point curve)		
16	**7th PV**	Engineering unit value for the 7th point		
17	**8th INPUT**	Input signal for the 8th point (of the 15 point curve)		
18	**8th PV**	Engineering unit value for the 8th point		
19	**9th INPUT**	Input signal for the 9th point (of the 15 point curve)		
20	**9th PV**	Engineering unit value for the 9th point		
21	**10th INPUT**	Input signal for the 10th point (of the 15 point curve)		
22	**10th PV**	Engineering unit value for the 10th point		
23	**11th INPUT**	Input signal for the 11th point (of the 15 point curve)		
24	**11th PV**	Engineering unit value for the 11th point		
25	**12th INPUT**	Input signal for the 12th point (of the 15 point curve)		
26	**12th PV**	Engineering unit value for the 12th point		
27	**13th INPUT**	Input signal for the 13th point (of the 15 point curve)		
28	**13th PV**	Engineering unit value for the 13th point		
29	**14th INPUT**	Input signal for the 14th point (of the 15 point curve)		
30	**14th PV**	Engineering unit value for the 14th point		
31	**15th INPUT**	Input signal for the15th point (of the 15 point curve)		
32	**15th PV**	Engineering unit value for the 15th point		

CONTROL

	Parameter	Description	Value Loop 1	Value Loop 2
1	**ALGORITHM**	Control algorithm used		
2	**D. SOURCE**	Variable used to determine the derivative value		
3	**ACTION:1**	Action of the first control output		
4	**FIXED LAG**	Fixed amount of lag between control iterations		
5	**VARBL. LAG**	Variable amount of lag between control iterations		
6	**MAX. LAG**	Maximum as result of PV2 action.		
7	**PV BREAK**	Output level if the process variable input is lost		
8	**LOW OUT.**	Lowest output value in automatic control		
9	**HIGH OUT.**	Highest output value in automatic control		
10	**FF LO LIM.**	Low limit for feed forward output contribution when Loop 2 is in automatic control		
11	**FF HI LIM.**	High limit for feed forward output contribution when Loop 2 is in automatic control		
12	**ACTION:2**	Action of the second control output		
13	**CCW TIME**	Time for motor to fully stroke in the CCW direction		
14	**CW TIME**	TIme for motor to fully stroke in the CW direction		
15	**MIN. TIME**	Minimum on-time for the motor before taking action		
16	**S/W RANGE**	Full range resistance of the slidewire		
17	**OPEN F/B**	Feedback ohm value when the valve is open		
18	**CLOSE F/B**	Feedback ohm value when the valve is closed		
19	**OUT1 STOP**	Stopping point for control output 1 when staging outputs		
20	**OUT2 STRT.**	Starting point for control output 2 when staging outputs		

ALARMS

	Parameter	Description	Value Loop 1	Value Loop 2
1	**ALM. TYPE:1**	Type of alarm for alarm 1		
2	**ALM. SRC.:1**	Source of value monitored by HIGH, LOW or HIGH/LOW alarm 1		
3	**ALARM SP:1**	Alarm setpoint for alarm 1 (except for HIGH/LOW)		
4A	**HIGH SP:1**	High alarm setpoint for HIGH/LOW alarm 1		
4B	**LOW SP:1**	Low alarm setpoint for HIGH/LOW alarm 1		
5	**DEADBAND:1**	Deadband for alarm 1		
6	**ALM.:1 OUT.**	Output number for alarm 1		
7	**LATCHING:1**	Latching sequence for alarm 1		
8	**ACK.:1**	Whether alarm 1 may be acknowledged		
9	**POWER UP:1**	How alarm 1 will be treated upon power up		
10	**MESSAGE:1**	Nine character message associated with alarm 1		
11	**ALM. TYPE:2**	Type of alarm for alarm 2		
12	**ALM. SRC.:2**	Source of value monitored by HIGH, LOW or HIGH/LOW alarm 2		
13	**ALARM SP:2**	Alarm setpoint for alarm 1 (except for HIGH/LOW)		
14A	**HIGH SP:2**	High alarm setpoint for HIGH/LOW alarm 2		
14B	**LOW SP:2**	Low alarm setpoint for HIGH/LOW alarm 2		
15	**DEADBAND :2**	Deadband for alarm 2		
16	**ALM.:2 OUT.**	Output number for alarm 2		
17	**LATCHING :2**	Latching sequence for alarm 2		
18	**ACK.:2**	Whether alarm 2 may be acknowledged		
19	**POWER UP:2**	How alarm 2 will be treated upon power up		
20	**MESSAGE:2**	Nine character message associated with alarm 2		
21	**FAULT**	Alarm relay status if fault condition is detected		
22	**OUTPUT**	Output if the rate-of-change alarm is tripped		
23	**RATE TIME**	Time period over which a rate-of-change alarm is determined		

REM. SETPT. (Global)

	Parameter	Description	Value
1	**TYPE V/mA**	Input signal to be used for remote setpoint	
2	**RSP: LO RNG.**	Engineering unit value corresponding to low remote setpoint input value	
3	**RSP: HI RNG.**	Engineering unit value corresponding to high remote setpoint input value	
4	**RSP: LOW**	Lowest setpoint value to be accepted from the remote setpoint source	
5	**RSP: HIGH**	Highest setpoint value to be accepted from the remote setpoint source	
6	**TRACKING**	Whether the local setpoint will track the remote setpoint	
7	**BIAS LOW**	Lowest bias value that may be entered	
8	**BIAS HIGH**	Highest bias value that may be entered	
9	**RSP FIXED**	What happens if remote setpoint is lost while active and then restored	

RETRANS. (Global)

	Parameter	Description	Value
1	**TYPE:2**	What is to be retransmitted for output 2	
2	**LO RANGE:2**	Low end of the range of output 2 in engineering units	
3	**HI RANGE:2**	High end of the range of output 2 in engineering units	
4	**TYPE:3**	What is to be retransmitted for output 3	
5	**LO RANGE:3**	Low end of the range of output 3 in engineering units	
6	**HI RANGE:3**	High end of the range of output 3 in engineering units	
7	**TYPE:4**	What is to be retransmitted for output 4	
8	**LO RANGE:4**	Low end of the range of output 4 in engineering units	
9	**HI RANGE:4**	High end of the range of output 4 in engineering units	

SELF TUNE

	Parameter	Description	Value Loop 1	Value Loop 2
1	**TYPE**	Type of self tuning algorithm that is available		
2	**PRETUNE**	Output step size in absolute percent		
3	**TUNE PT.**	TYPE 1: Defines the PV value at which the output switches off		
4	**OUT. STEP**	TYPE 2 & 3: Defines output step size in absolute percent		
5	**LOW LIMIT**	Lower limit PV can reach during Pretune before aborting		
6	**HI LIMIT**	Upper limit PV can reach during Pretune before aborting		
7	**TIMEOUT**	Execution time limit for Pretune before aborting		
8	**MODE**	Control mode after Pretune is completed or aborted		
9	**NOISE BND.**	Noise band to be used by adaptive tuning algorithm		
10	**RESP. TIME**	Response time to be used by adaptive tune		
11	**DEAD TIME**	Process run time before controller responds to output change		

SPECIAL

	Parameter	Description	Value Loop 1	Value Loop 2
1	**AUTO. TRIP**	Manual to Auto Control trip method		
2	**TRIP DEV.**	Deviation from setpoint at which controller will trip to auto		
3	**DES. OUT. N**	Output value for a designated digital input on trip to manual		
4	**POWER UP**	Control mode upon power up		
5	**PWR. UP:OUT.**	Output of the controller is powering up in manual control		
6	**PWR. UP: SP**	Setpoint upon power up		
7	**NO. OF SP**	Number of stored setpoints stored for selection		

SECURITY (Global)

	Parameter	Description	Value
1	**SEC. CODE**	Security code for temporarily unlocking the instrument	
2	**SP ADJUST**	Lockout status for setpoint changes	
3	**AUTO./MAN.**	Lockout status for MANUAL key	
4	**SP SELECT**	Lockout status for SETPT key	
5	**ALARM ACK.**	Lockout status for ACK key	
6	**TUNING**	Lockout status for adjustment of tuning parameters	
7	**CONFIGURE**	Lockout status for Set Up Parameters	

SER COMM. (Global)

	Parameter	Description	Value
1	**STATION**	The unit's station address	
2	**BAUD RATE**	Baud rate	
3	**CRC**	Whether CRC is being calculated	
4	**SHED TIME**	Time interval between communications activity before controller sheds	
5	**SHED MODE**	State of the controller if communications is lost (sheds)	
6	**SHED OUT.**	Output if the unit sheds	
7	**SHED SP**	Setpoint status if communications is lost	
8	**DESIG. SP**	Value of the setpoint if controller sheds	

Software Configuration

CHAPTER 6
TUNING

OVERVIEW

The self tune function of the 545 consists of two distinct components — Pretune and Adaptive Tune. In addition, you may choose from three type of Pretune:

TYPE 1 - for slow thermal processes.

TYPE 2 - for fast fluid or pressure processes.

TYPE 3 - for level control applications.

- Choose the type of Pretune in the **SELF TUNE** menu.
- Pretune and Adaptive Tune may be used separately or together. Refer to Chapter 7 for more information.
- Each control loop has its own set of **TUNING** parameters.

On the following pages is the step by step guide to the tuning parameters.

NOTE:
For more information about Pretune and Adaptive Tune, refer to section on Tuning applications in Chapter 7.

NOTE:
Loop 1 is in the foreground upon power up. When Loop 2 is in the foreground, both the PV2 icon and DISPLAY key will be lit.

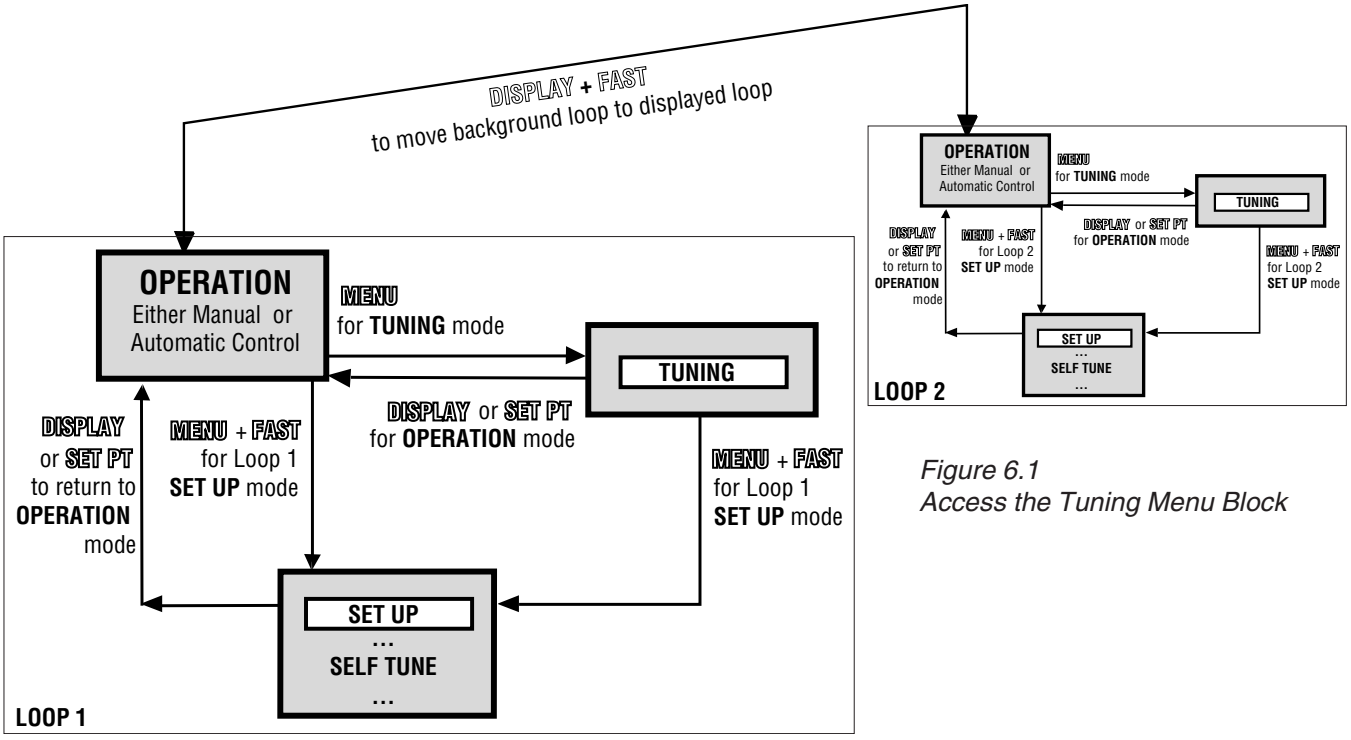


Figure 6.1
Access the Tuning Menu Block

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

TUNING

ADAPTIVE
DISABLED

PRETUNE
NO

POWR. BACK
DISABLED

PROP. BND.:1
50.0

RESET:1
20

RATE:1
1

MAN. RST.:1
0

CYCLE TM.:1
15.0

TUNING

1. ADAPTIVE

Activates the self tune algorithm (upon transfer to automatic control).

D DISABLED
• ENABLED

2. PRETUNE

Activates the pretune algorithm (if unit is under manual control).

To initiate the Pretune cycle, press the ▲ or ▼. Confirm by pressing **ACK** within two seconds.

D NO

3. **POWR. BACK**

Reduces setpoint overshoot at power up or after setpoint changes.

D DISABLED
• ENABLED

4. **PROP. BND.:1**

Defines the proportional band for PID set 1.

R 0.1 to 999.0%
D 50.0%

5. **RESET:1**

Defines the integral time for PID set 1.

R 1 to 9999 seconds
D 20 seconds

6. RATE:1

Defines the derivative time for PID set 1.

R 0 to 600 seconds
D 1 second

7. MAN. RST.:1 (or LOADLINE:1)

Defines the manual reset for PID set 1. If using automatic reset, then this specifies the load line out value.

R 0 to 100%
D 0%

8. CYCLE TM.:1

Defines the cycle time for control output 1 when using a time proportioning output.

R 0.3 to 120.0 seconds
D 15.0 seconds

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

9. CTRL. D.B.

Defines the control deadband when using PID, PI, PD, P or PID On/Off Control.

R Any positive value

D 15.0 seconds

10. DEADBAND:1

Defines the dead band for control output 1 when using on/off control.

R 1 to 99999 in engineering units

D 2

11. P. PROP. D.B.

Defines the dead band setting for a slidewire position proportioning output.

R 0.5 to 10.0%

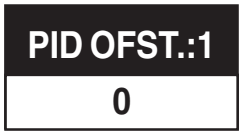
D 2.0%

12A. PID OFST.:1

For duplex applications, defines the offset for the first output.

R –50.0% to 50.0%

D 0.0%

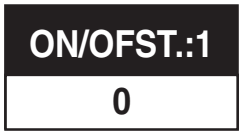


12B. ON OFST.:1

For On/Off applications, defines the offset for the first output.

R -9999 to 99999 in engineering units

D 0

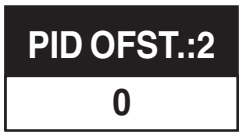


13A. PID OFST.:2

For duplex applications, defines the offset for the second output.

R –50.0% to 50.0%

D 0.0%



13B. ON OFST.:2

For On/Off applications, defines the offset for the second output.

R -9999 to 99999 in engineering units

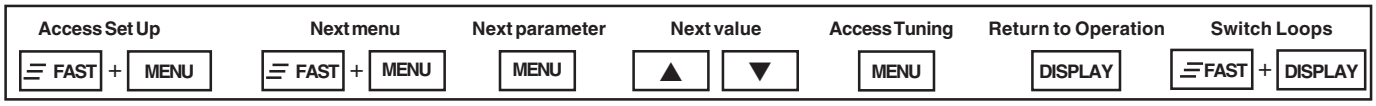
D 0

14. REL. GAIN:2

Defines the adjustment factor for the second output's proportional band. It is multiplied by the effective gain of output 1 to obtain the second output's proportional band.

R 0.1 to 10.0

D 1.0



CYCLE TM.:2
15.0

15. CYCLE TM.:2

Defines the cycle time for control output 2 when using a time proportioning output.

R 0.3 to 120.0 seconds.

D 15.0 seconds

DEADBAND:2
2

16. DEADBAND:2

Defines the dead band for control output 2 when using on/off control.

R 1 to 99999 in engineering units

D 2

RSP RATIO
1.00

17. RSP RATIO

Defines the multiplier applied to the remote set point.

R -99.99 to 99.99

D 1.00

RSP BIAS
(D)

18. RSP BIAS

Defines the bias (additive term) applied to the remote set point.

R Any value in engineering units (minimum is BIAS LOW; maximum is BIAS HIGH)

D Dependent on the BIAS LOW and BIAS HIGH values

FFWD. GAIN
1.00

19. FFWD GAIN

Multiplier applied to the feed forward input.

R -99.99 to 99.99

D 1.00

FFWD. ZERO
0

20. FFWD ZERO

Zero point of the feed forward output contribution.

R -9999 to 99999

D 0

FF.BRK.GN
1.00

21. FF.BRK.GN

Multiplier applied to the feed forward input if PV is broken.

R -99.99 to 99.99

D 1.00

FF.BRK.ZR.
0

22. FF.BRK.ZR.

Zero point of the feed forward input contribution if PV is broken.

R -9999 to 99999

D 0

NO. OF PID
1

23. NO. OF PID

Defines the number of PID sets that will be stored and available for use.

R 1 to 8 For numbers>1, PID TRIP defines tripping between the PID sets

- SP NUMBER Number of PID sets = number of local setpoints (specified in NO. OF SP). Each PID set has a respective SP NUMBER.

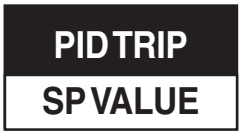
D 1

Access Set Up	Next menu	Next parameter	Next value	Access Tuning	Return to Operation	Switch Loops
FAST + MENU	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY	FAST + DISPLAY

24. PID TRIP

For NO. OF PID > 1, defines the variable used to select the various PID sets.

- PV VALUE PID set selection based on process variable
- D SP VALUE PID set selection based on setpoint
- DEV. VALUE PID set selection based on deviation from setpoint

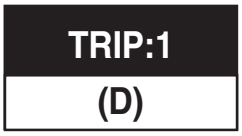


25. TRIP:1

Defines the value that triggers a change to the primary set (#1) of PID values.

R The process variable range

D Dependent on the process variable range



FOR EACH SET OF PID 2 THROUGH 8, you need to set up the following group of parameters (X represents the PID set number). Set up the parameters as they appear for each set of PID. **The controller designates the values for the active PID parameter in the third display with an "*" on either side.**

26. PROP. BND.:X

Defines the proportional band for PID set X.

R 0.1 to 999.0%

D 50.0%

27. RESET:X

Defines the integral time for PID set X.

R 1 to 9999 seconds (increments of 1)

D 20 seconds

28. RATE:X

Defines the derivative time for PID set X.

R 0 to 600 seconds

D 1 second

29. MAN. RST.:X (or LOADLINE:X)

Defines the manual reset (or load line) for PID set X.

R 0 to 100%

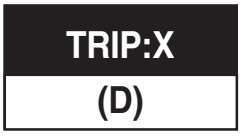
D 0%

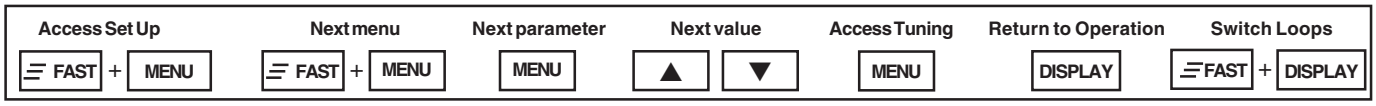
30. TRIP:X

This defines the value that triggers a change to the Xth set of PID values.

R The process variable range

D Dependent on the process variable range





TUNING

Parameter	Definition	Value Loop 1	Value Loop 2
1. ADAPTIVE	Activates the self tune algorithm		
2. PRETUNE	Activates the pretune algorithm		
3. POWR. BACK	Reduces setpoint overshoot		
4. PROP. BND.:1	Defines the proportional band for PID set 1		
5. RESET:1	Defines the integral time for PID set 1		
6. RATE:1	Defines the derivative time for PID set 1		
7. MAN. RST.:1	Defines the manual reset for PID set 1		
8. CYCLE TM.:1	Defines the cycle time for control output 1		
9. CTRL. D.B.	Control deadband for PID, PI, PD, P or PID On/Off		
10. DEADBAND:1	Defines the dead band for control output 1		
11. P. PROP. D.B.	Defines the dead band setting for a slidewire output		
12A. PID OFST.:1	For duplex applications, defines the offset for the first output		
12B. ON OFST.:1	For On/Off applications, defines the offset for the first output		
13A. PID OFST.:2	For duplex applications, defines the offset for the 2nd output		
13B. ON OFST.:2	For On/Off applications, defines the offset for the 2nd output		
14. REL. GAIN:2	Defines the adjustment factor for the output 2 prop. band		
15. CYCLE TM.:2	Defines the cycle time for control output 2		
16. DEADBAND:2	Defines the dead band for control output 2		
17. RSP RATIO	Defines the multiplier applied to the remote set point		
18. RSP BIAS	Defines the bias (additive term) applied to the remote set point		
19. FFWD GAIN	Adjustment factor for feed forward input		
20. FFWD ZERO	Zero point of feed forward output contribution		
21. FF.BRK.GN	Adjustment factor for feed forward input if PV is broken		
22. FF.BRK.ZR.	Zero point for feed forward output contribution if PV is broken		
23. NO. OF PID	Defines the number of stored and available PID sets		
24. PID TRIP	Defines the variable used to select the various PID sets		
25. TRIP:1	Defines the value that triggers a change to primary PID set		
26. PROP. BND.:2	Defines the proportional band for PID set 2		
27. RESET:2	Defines the integral time for PID set 2		
28. RATE:2	Defines the derivative time for PID set 2		

29. MAN. RST.:2	Defines the manual reset (or load line) for PID set 2		
30. TRIP:2	Defines the value that triggers a change to the 2nd PID set		
31. PROP. BND.:3	Defines the proportional band for PID set 3		
32. RESET:3	Defines the integral time for PID set 3		
33. RATE:3	Defines the derivative time for PID set 3		
34. MAN. RST.:3	Defines the manual reset (or load line) for PID set 3		
35. TRIP:3	Defines the value that triggers a change to the 3rd PID set		
36. PROP. BND.:4	Defines the proportional band for PID set 4		
37. RESET:4	Defines the integral time for PID set 4		
38. RATE:4	Defines the derivative time for PID set 4		
39. MAN. RST.:4	Defines the manual reset (or load line) for PID set 4		
40. TRIP:4	This defines the value that triggers a change to the 4th PID set		
41. PROP. BND.:5	Defines the proportional band for PID set 5		
42. RESET:5	Defines the integral time for PID set 5		
43. RATE:5	Defines the derivative time for PID set 5		
44. MAN. RST.:5	Defines the manual reset (or load line) for PID set 5		
45. TRIP:5	This defines the value that triggers a change to the 5th PID set		
46. PROP. BND.:6	Defines the proportional band for PID set 6		
47. RESET:6	Defines the integral time for PID set 6		
48. RATE:6	Defines the derivative time for PID set 6		
49. MAN. RST.6	Defines the manual reset (or load line) for PID set 6		
50. TRIP:6	This defines the value that triggers a change to the 6th PID set		
51. PROP. BND.:7	Defines the proportional band for PID set 7		
52. RESET:7	Defines the integral time for PID set 7		
53. RATE:7	Defines the derivative time for PID set 7		
54. MAN. RST.:7	Defines the manual reset (or load line) for PID set 7		
55. TRIP:7	This defines the value that triggers a change to the 7th PID set		
56. PROP. BND.:8	Defines the proportional band for PID set 8		
57. RESET:8	Defines the integral time for PID set 8		
58. RATE:8	Defines the derivative time for PID set 8		
59. MAN. RST.:8	Defines the manual reset (or load line) for PID set 8		
60. TRIP:8	This defines the value that triggers a change to the 8th PID set		

SELF TUNE MESSAGES AND TROUBLESHOOTING

Refer to Chapter 7 for more information on the Self Tune function of the 545 controller.

When the Pretune function terminates, one of the following messages will appear:

Message	Pretune Type	Conclusion/Problem	Corrective Action
COMPLETED	1	PRETUNE has generated initial PID and the Dead Time values.	
	2, 3	PRETUNE has generated initial PID, Response Time, Noise Band and the Dead Time values.	
ABORTED	1, 2, 3	User has aborted PRETUNE before completion.	
LIMIT ERR.	1	The Process Variable went beyond the HI LIMIT or LOW LIMIT.	Change the HI LIMIT and LOW LIMIT, or the HIGH OUT and LOW OUT, and run PRETUNE again.
	2, 3	The Process Variable went beyond the HI LIMIT or LOW LIMIT.	Change the HI LIMIT and LOW LIMIT, or the OUT.STEP size, and run PRETUNE again.
	1, 2, 3	The initial Process Variable was near or beyond the HI LIMIT or LOW LIMIT.	Change the manual output percentage, or the HI LIMIT and LOW LIMIT, and run PRETUNE again.
TIME OUT	1, 2, 3	TIMEOUT limit was reached before PRETUNE completed.	Set a longer TIMEOUT period and/or increase the OUT.STEP size, and run PRETUNE again.
NOISE ERR.	1, 2, 3	Too much PV noise was detected.	Eliminate the noise source (if possible) or increase the OUT.STEP and run PRETUNE again.
INPUT ERR.	1, 2, 3	PV or Cold Junction break detected during PRETUNE.	Check the described conditions and make corrections or repairs.
	1, 2, 3	PV HIGH or PV LOW detected during PRETUNE.	
	1, 2, 3	SLIDEWIRE break detected during PRETUNE.	
	1, 2, 3	REMOTE SP break detected during PRETUNE.	
OUT. ERROR	1, 2, 3	The initial control output is outside the high and low limits defined in the Control Menu.	Change the manual output percent and run PRETUNE again.
DATA ERR.	2,3	The PV moved too quickly to be Analyzed.	Increase the OUT.STEP size and run PRETUNE again.
ZERO ERR.	2,3	One or more model parameters are calculated to be zero.	Increase the OUT.STEP size and run PRETUNE again.
DEV. ERROR	1	The initial PV is too close to the TUNE PT.	Move Tune PT. (or the set point if TUNE PT. is automatic) farther from the process variable and run PRETUNE again.
RETRY	1, 2, 3	The Process Variable went beyond the HI LIMIT or LOW LIMIT.	Check if any PID values are generated and if they are acceptable. If not, eliminate noise sources (if possible) and run PRETUNE again.

If Pretune and Adaptive Tune do not generate optimal PID values for control, check the following menu entries:

Message	Potential Problem	Corrective Action
RESPONSE TIME	Adaptive Tune cannot run if RESPONSE TIME is inaccurate	Run TYPE 2 or TYPE 3 Pretune to obtain the correct value, or enter it manually.
NOISE BAND	Adaptive Tune cannot compensate for PV oscillation due to hysteresis of output device (e.g., a sticky valve).	Set NOISE BAND large enough to prevent Adaptive Tune from acting on the oscillation. If oscillation is not acceptable, consider replacing valve.
PRETUNE	Pretune does not develop optimum PID parameters.	Wrong Pretune TYPE selected. Refer to Chapter 7, the Section on Self Tune.

CHAPTER 7
APPLICATIONS

NOTE:
Controller capabilities depend upon the specified hardware option.

The 545 controller provides a variety of user-programmable control features and capabilities. The following topics are included in this chapter:

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W. Feed Forward/Feedback Control 107
X. Lag Time 108

A. CONTROL TYPE

Each of the control loops in the 545 can be independently configured.

Software Configuration

1. Go to the **CONTROL** menu.
2. For the parameter **ALGORITHM**, select the type of 545 control:
   - **ON-OFF**
     "Crude" control similar to a household thermostat. Used primarily on slow, stable processes where moderate deviation (cycling) around setpoint is tolerable. Only available with SSR, SSR Drive, and relay outputs.
   - **P**
     Proportional only control. Provides much better control than on/off. Used on processes that are less stable or require tighter control, but have few load variations and do not require a wide range of setpoints.
   - **PI**
     Proportional plus integral control. In addition to proportional control, it compensates for control errors due to a wide range of setpoints or load requirements. The integral term works to eliminate offsets.
   - **PD**
     Proportional plus derivative control. In addition to proportional control, it compensates for control errors due to fast load variations.
   - **PID**
     Proportional plus integral plus derivative control. In addition to proportional control, it compensates for changes in setpoint, load requirements and process variations.
   - **PID/ON-OFF**
     Only available with Duplex control. First output uses the PID algorithm, while second output uses on/off control.

3. For algorithms using the derivative function (D), choose the conditions for the derivative term:

   Scroll to parameter **D. SOURCE**

   - For derivative action based on error, or deviation from setpoint, choose DEVIATION
   - For derivative action based on PV changes, choose PV.

B. ALARMS

Each loop of the 545 controller has two extremely flexible and powerful software alarms (4 alarms total). The number of available outputs limits how alarms are linked to relays. A Global Alarm feature allows all alarms to be assigned to the same relay.

The 545 indicates an alarm condition(s) for the foreground loop by:

- Lit icons **ALM 1** and/or **ALM 2**
- Lit **ACK** key
- Displayed alarm message

The 545 indicates an alarm condition(s) for the background loop by:

- Showing the (user defined) message for one or both alarms in the third display (alternate displays for simultaneous alarms).

Software Configuration

1. Access the **ALARM** menu.
2. Set values for the following parameters. All possible values are shown. Remember: there are 2 alarms for each loop (use **FAST+DISPLAY** to switch loops).

   ALM.TYPE:1 and **ALM. TYPE:2**

   Specifies the type of alarm to implement. Selection includes:

   - **HIGH ALARM**

     High process variable alarm. Occurs when the process variable exceeds the alarm setpoint.
   - **LOW ALARM**

     Low process variable alarm. Occurs when the process variable goes below the alarm setpoint.
   - **HIGH/LOW**

     Combination of high and low alarms. Occurs when the PV exceeds the individually set high or low setpoint.
   - **BAND**

     Creates a band centered around the control setpoint, that is twice the alarm setpoint. Alarm occurs when the process variable travels outside of this band. The alarm is dependent on the control setpoint. As the control setpoint changes, the band adjusts accordingly.

     For example, if the control setpoint is 500 and the alarm setpoint is 25, then the band extends from 475 to 525.
   - **DEVIATION**

     Similar to the band alarm but creates a band only on one side of the control setpoint. Alarm occurs when the process variable deviates from the control setpoint by an amount greater than the alarm setpoint. This alarm is dependent on the control setpoint; as the control

NOTE:
The ability to base alarms on parameters other than PV greatly expands the alarm capacity.

setpoint changes, the alarm point changes.

For example, if the control setpoint is 500 and the alarm setpoint is +50, then an alarm occurs when the process variable exceeds 550. In order for an alarm to occur when the process variable drops below 450, select an alarm setpoint of –50.

- **MANUAL**

  Alarm occurs when the controller is put into manual mode of operation. This may be useful for security purposes or to alert the operator that 545 is no longer under automatic control.

- **RATE**

  Alarm occurs when the process variable changes at a rate greater than what is specified by the alarm setpoint and time base. This alarm helps to anticipate problems before the process variable can reach an undesirable level.

  For example, if the alarm setpoint is 10 with a time base of 5 seconds, an alarm occurs whenever a change in process variable greater than 10 occurs in 5 seconds.

ALM.SRC.:1 and ALM.SRC.:2

For HIGH , LOW or HIGH/LOW alarms, specifies the variable (source) upon which a selected alarm is based. Selection includes:

- PV
- PV2
- SP
- RAMP SP
- DEVIATION
- OUTPUT

ALARM SP:1 and ALARM SP:2

Defines the point at which an alarm occurs. For a RATE (rate of change) alarm, it specifies the amount of change (per RATE TIME period) that must occur before the alarm activates. A negative value specifies a negative rate-of-change. Does not apply to HIGH/LOW alarms.

HIGH SP:1 and HIGH SP:2

For a HIGH/LOW alarm, defines the high setpoint at which an alarm occurs.

LOW SP:1 and LOW SP:2

For a HIGH/LOW alarm, defines the low setpoint at which an alarm occurs.

DEADBAND:1 and DEADBAND:2

Specifies the range through which the process variable must travel before leaving an alarm condition (see alarm examples at the end of this section). Prevents frequent alarm oscillation or “chattering” if the process variable has stabilized around the alarm point.

ALM.1 OUT and ALM.2 OUT

For any enabled alarm, selects the output number to which the selected alarm will be assigned. It is possible to assign both alarms to the same output relay, thus creating a “global” alarm .

Alarm Parameters Reference

For Alarm 1

Parameter	Description
ALM. TYPE:1	Type
ALM. SRC.:1	Source
ALARM SP:1	Setpoint
HIGH SP:1	High setpoint
LOW SP:1	Low setpoint
DEADBAND:1	Deadband
ALM.:1 OUT.	Output number
LATCHING:1	Latching sequence
ACK.:1	Acknowledging
POWER UP:1	Status on power up
MESSAGE:1	Message

For Alarm 2

Parameter	Description
ALM. TYPE:2	Type
ALM. SRC.:2	Source
ALARM SP:2	Setpoint
HIGH SP:2	High setpoint
LOW SP:2	Low setpoint
DEADBAND:2	Deadband
ALM.:2 OUT.	Output number
LATCHING:2	Latching sequence
ACK.:2	Acknowledging
POWER UP:2	Status on power up
MESSAGE:2	Message

For either alarm
(depending on choices)

Parameter	Description
FAULT	Fault assignment
OUTPUT	Output action for rate
RATE TIME	Time base for rate

NOTE:
Each of the two loops has two alarms.

LATCHING:1 and LATCHING:2

A latching (YES) alarm will remain active after leaving the alarm condition unless it is acknowledged. A non-latching (NO) alarm will return to the non-alarm state when leaving the alarm condition without being acknowledged.

ACK.:1 and ACK.:2

For any enabled alarm, enables or disables operator use of the **ACK** key to acknowledge an alarm at any time, even if the control process is still in the alarm condition.

A latching alarm can always be acknowledged when it is out of the alarm condition. When either alarm is available to be acknowledged, the **ACK** key will be illuminated. If both alarms are acknowledgeable, pressing **ACK** will first acknowledge alarm #1. Pressing **ACK** a second time will acknowledge alarm #2.

POWER UP:1 and POWER UP:2

For any enabled alarm, selects the alarm condition upon power up. Choices are:

- **NORMAL**
  Controller will power up in alarm only if it is in alarm condition.
- **ALARM:**
  Controller always powers up in alarm regardless of system's alarm condition. This is an excellent way to activate an alarm if there has been a power failure.
- **DELAYED**
  Controller will never power up in alarm, regardless of system's alarm condition. The system must leave and reenter the alarm condition before the alarm will activate. This is typically used to avoid alarms during start up.

MESSAGE:1 and MESSAGE:2

Allows user to specify a nine-character message to be displayed when the respective alarm is active. If both alarms are active or any other diagnostic message is present, the messages will alternate.

FAULT

Activates an alarm if the process variable signal is lost. Assign this function to either Alarm 1 or Alarm 2 (not both). This action is in addition the selected alarm type (additive alarm function).

OUTPUT

For a RATE alarm, selects the output action. Use to obtain early indication of a possible break in the process variable signal. Select PV BREAK to have rate-of-change alarm take the same action as a detection of a break in the process variable signal (where it trips to manual control at a predetermined output).

RATE TIME

For RATE alarms, defines the time period over which a discrete change in process variable must occur for the rate alarm to be activated. The amount of change is defined by the alarm setpoint. The rate-of-change is defined as the amount of change divided by the time period.

Example

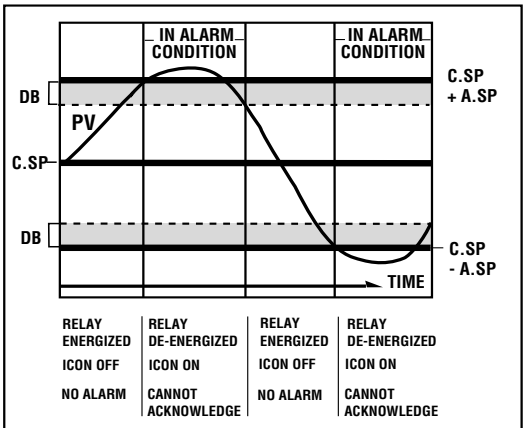
A. If the alarm setpoint is set to 10 and the time base is set to 1 second, the rate of change is 10 units per second.

B. If the alarm setpoint is set to 100 and the time base set to 10, the rate of change is also 10 units per second.

In example A, the process variable would only have to experience a ten unit change over a short period of time, while in Example B, it would require a 100 unit change over a ten second period. Example A is much more sensitive than Example B. In general, for a given rate-of-change, the shorter the time period, the more sensitive the rate alarm.

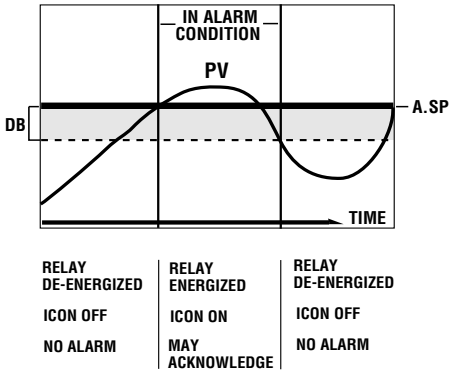
Figure 7.1
Alarm Examples

BAND ALARM



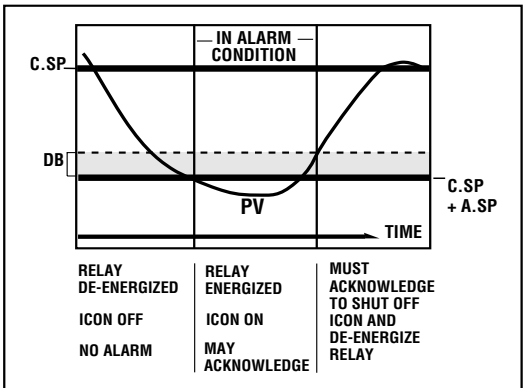
PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:OFF (N = 2 to 4)
ALM. TYPE:1 = BAND
ALM.:1 OUT. = N (N= 2 to 4)
LATCHING = NO LATCH
ACK.:1 = DISABLED

HIGH PROCESS VARIABLE ALARM



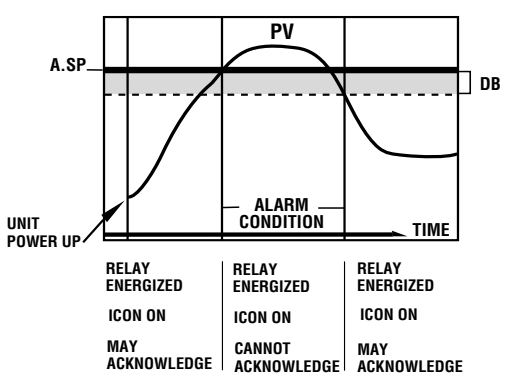
PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:ON (N = 2 to 4)
ALM. TYPE:1 = HIGH ALRM.
ALM.:1 OUT. = N (N = 2 to 4)
LATCHING = NO LATCH
ACK.:1 = ENABLED

DEVIATION ALARM



PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:ON (N = 2 to 4)
ALM. TYPE:1 = DEVIATION
ALM.:1 OUT. = N (N = 2 to 4)
LATCHING = LATCH
ACK.:1 = ENABLED
ALARM SP:1 = (<0)

POWER UP ALARM



PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:ON (N = 2 to 4)
ALM. TYPE:1 = HIGH ALM.
ALM.:1 OUT. = N (N = 2 to 4)
LATCHING:1 = LATCH
ACK.:1 = DISABLED
POWER UP:1 = ALARM

NOTE: The duplex output states vary depending upon:
1. Control Type (PID, On/Off, etc.)
2. Control Action (DA, RA)
3. Output Limits
4. Output Gap or Overlay, and
5. Output 2 Relative Gain and PID% Output.

Please refer to the output state examples in this section to confirm that the configuration is appropriate for the process.

NOTE: Set manual reset/load line parameters to 50% when using Duplex control (MAN. RST.:X parameter is in the TUNING menu.)

C. DUPLEX CONTROL

The Duplex control algorithm enables two discrete control outputs for the control loop. Duplex control is commonly used for applications that require both heating and cooling or when 2 control elements are needed to achieve the desired result.

Hardware Configuration

- The controller must have two output modules assigned to the loop (any combination of output modules).

Software Configuration

1. Go to the **CONFIG.** menu.
   Set **LOOP1 OUT** or **LOOP2 OUT.** to DUPLEX.
2. To use different algorithms for each output (PID for the first, and On/Off for the second):
   Go to the **CONTROL** menu.
   Set **ALGORITHM** to PID:ON/OFF.
3. To make the control action for each output independent of the other:
   Go to the **CONTROL** menu.
   Set **ACTION:1** or **ACTION:2** to either DIRECT or REVERSE action based on the diagrams in the output examples section (Figures 7.2 through 7.8).
4. Go to the **TUNING** menu.
   Set values for **PID OFST:1** (or **ON OFST:1**) and **PID OFST:2** (or **ON OFST:2**). These parameters allow the user to independently offset the point at which output 1 and output 2 become active. **PID OFSET** units are in percent (%) of control output; **ON OFST** is in engineering units. The settings can be used to make sure there is a dead band, i.e., no controller output around setpoint. They can also be used to overlap output 1 and output 2 so that both are “on” in a small band around setpoint.
5. Set **MAN. RESET** (manual reset) term to 50%. This causes the PID output to be 50% when there is zero error. This term is still active as a “load line” setting when using automatic reset (integral), so set it to 50% whether using automatic reset or not.
6. **REL. GAIN** (relative gain) changes the gain of Output 2 relative to Output 1. Note that the relative gain can limit the maximum output available for Output 2 when using PID control.
7. Go to the **CONTROL** menu.
   Set **LOW OUT.** and **HIGH OUT.** to limit the maximum or minimum outputs from Output 1 and Output 2. The actual limitation on the outputs is dependent on the offset settings, the relative gain setting and the control action.

Duplex Output State Examples

The following Duplex examples represent a variety of ways this function can be set up. PID control examples show the PID output percentage on the horizontal axis, and On/Off control examples show the process variable on the horizontal axis. The vertical axes are the output of each physical output. Most of these examples use the first output as heating and the second output as cooling.

When using PID control, the 545 controller actually displays the PID output. To relate this output to the actual physical output, locate the PID output on the horizontal axis. Draw a vertical line at that point. At the intersection of this vertical

line and the respective output line, draw a horizontal line. The physical output is the value where this horizontal line intersects the respective axis.

The illustrations assume a manual reset/load line term of 50%. Therefore, at zero error (process variable equals setpoint) the PID output is 50%.

Duplex with reverse and direct acting outputs

A reverse acting output 1 and a direct acting output 2 with: no offset, no restrictive outputs limits, and a neutral relative gain with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

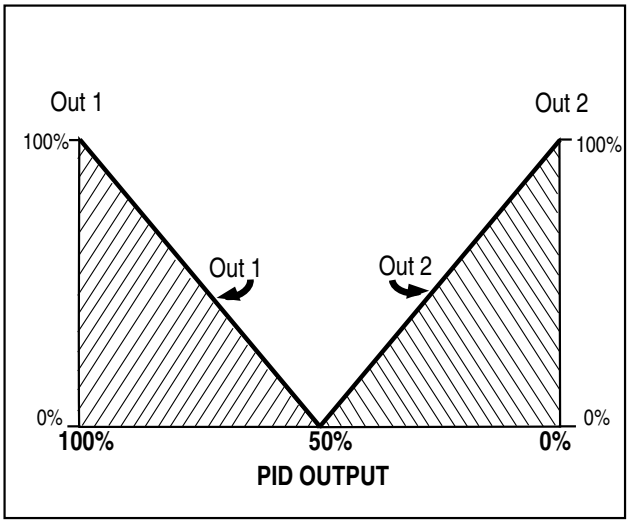


Figure 7.2
Duplex with Reverse and Direct Acting Outputs

Duplex with direct and reverse acting outputs

A reverse acting output 1 and a direct acting output 2 with: no offset, no restrictive output limits, and a neutral relative gain with PID control.

PARAMETER SETTINGS
ACTION:1 = DIRECT
ACTION:2 = REVERSE
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

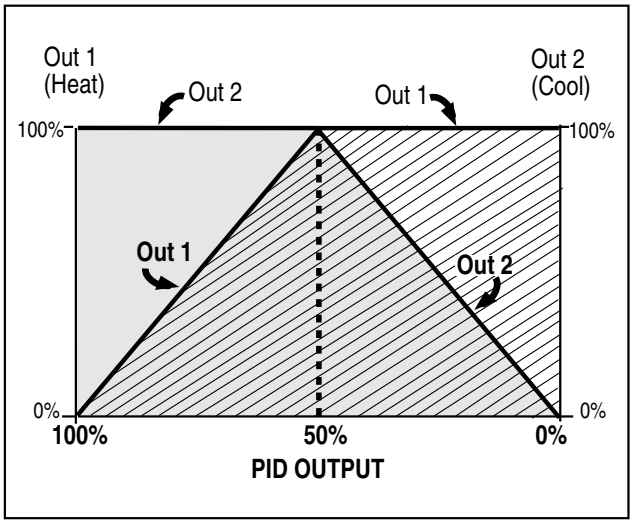


Figure 7.3
Duplex with Direct and Reverse Acting Outputs

Duplex with 2 reverse acting outputs

Two reverse acting outputs with: no offset, no restrictive output limits, and a neutral relative gain with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = REVERSE
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

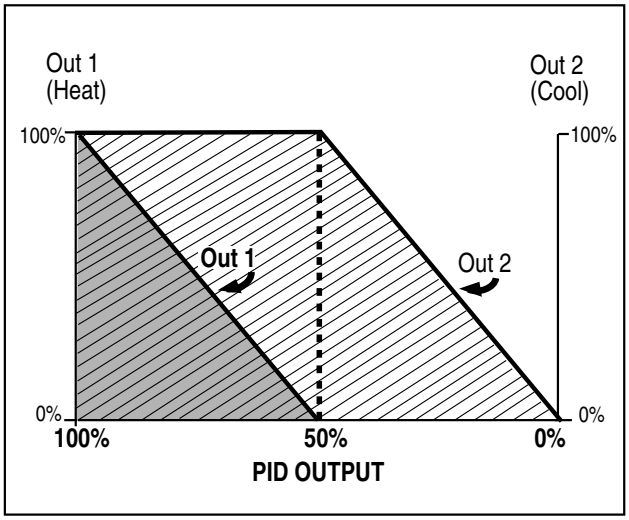


Figure 7.4
Duplex with Two Reverse Acting Outputs

Duplex with a gap between outputs

A reverse acting output 1 and a direct acting output 2 react with: a positive offset for output 1 and a negative offset for output 2 (assume no restrictive output limits and a neutral relative gain with PID control).

On the graph, a positive offset refers to an offset to the left of 50%; a negative offset is to the right of 50%.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = + VALUE
PID OFST.:2 = – VALUE
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

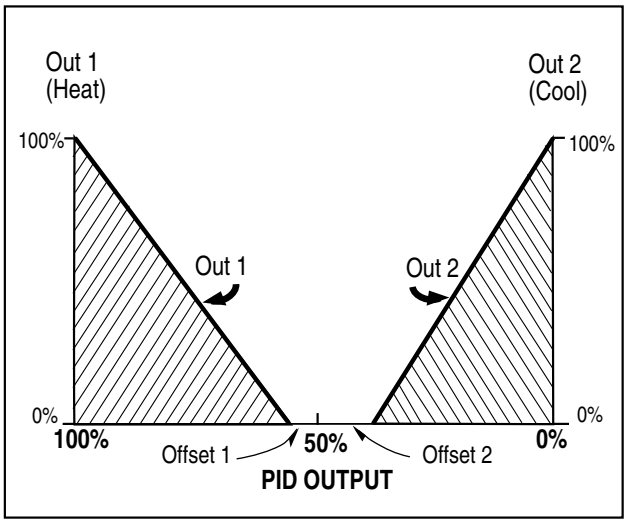


Figure 7.5
Duplex with a Gap Between Outputs

Duplex with a overlapping outputs and output limits

A reverse acting output 1 and a direct acting output 2 with: a negative offset for output 1, a positive offset for output 2, and restrictive high and low output limits with PID control.

This combination of offsets results in an overlap where both outputs are active simultaneously when the PID output is around 50%.

The output limits are applied directly to the PID output. This in turn limits the actual output values. In this example, the high output maximum limits the maximum value for output 1, while the low output minimum limits the maximum value for output 2. The value the actual outputs are limited to depends on offset settings, control action and relative gain setting with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = – VALUE
PID OFST.:2 = + VALUE
LOW OUT = 10%
HIGH OUT = 85%
REL. GAIN = 1.0

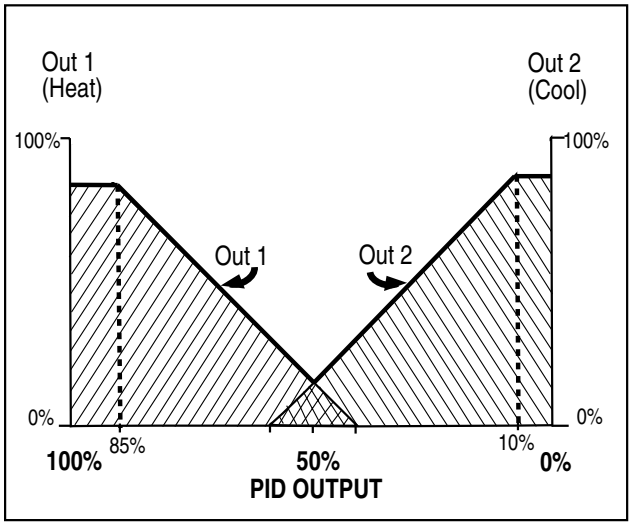


Figure 7.6
Duplex with Overlapping Outputs and Output Limits

Duplex with various relative gain settings

A reverse acting output 1 and a direct acting output 2 with: various relative gain settings (assume no offset or restrictive outputs) with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN ❶ = 2.0
REL. GAIN ❷ = 1.0
REL. GAIN ❸ = 0.5

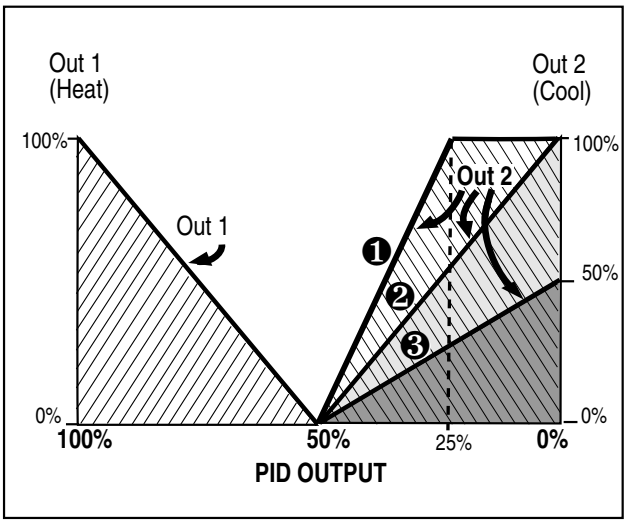


Figure 7.7
Duplex with Various Relative Gain Settings

Notice that the relative gain setting does not affect output 1. In this example, a relative gain setting of 2.0 (curve 1) results in output 2 reaching its maximum value at a PID output of 25%. A relative gain setting of 1.0 results in output 2 reaching its maximum value at a PID output of 0%. A relative gain setting of 0.5 results in output 2 reaching a maximum of 50% at a PID output of 0%.

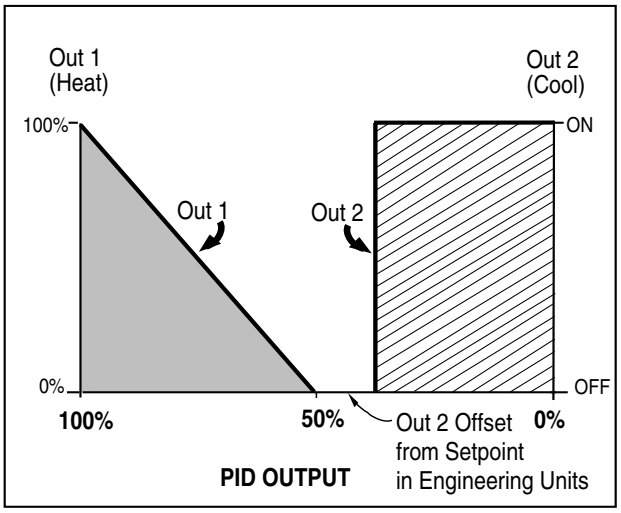
Duplex with one ON/OFF output

A reverse acting output 1 and a direct acting, on/off output 2 with a positive offset.

Relative gain does not apply when using duplex with an on/off output. The deadband setting for output 2 works the same as the deadband in single on/off control (the deadband effect for output 2 is not illustrated here).

Figure 7.8
Duplex with One ON/OFF Output

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = 0
ON OFST.:2 = + VALUE
LOW OUT = 0
HIGH OUT = 100



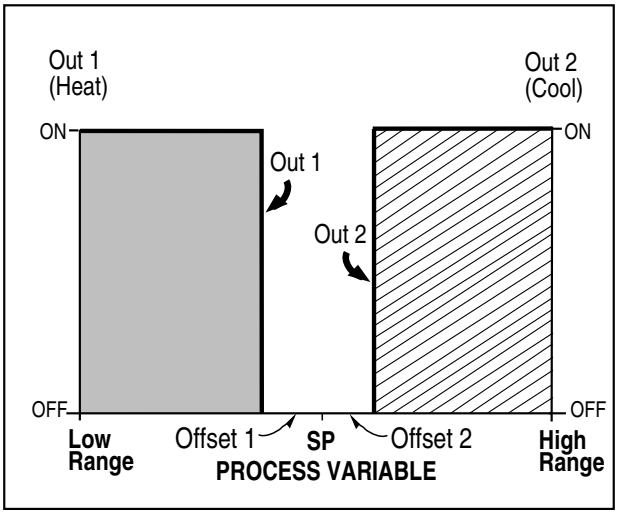
Duplex with two ON/OFF outputs

A reverse acting on/off output 1 and a direct acting on/off output 2 with a negative offset for output 1 and a positive offset for output 2.

Note that here the horizontal axis is expressed in terms of process variable rather than PID output.

Figure 7.9
Duplex with Two ON/OFF Outputs

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
ON OFST.:1 = – VALUE
ON OFST.:2 = + VALUE



D. SLIDEWIRE POSITION PROPORTIONING CONTROL

Slidewire position proportioning utilizes a slidewire feedback signal to determine the actual position of the actuator being controlled. **This option is only available for one of the two control loops.**

Hardware Configuration

- The controller **must** have the Slidewire Feedback option installed. Refer to the order code in Chapter 1 for more information.
- The controller must have mechanical relays, solid state relays or DC logic modules installed in the two output sockets corresponding to one control loop (1 or 2).
- The Slidewire does NOT have to be wired to the controller in order to set up position proportioning.

Software Configuration

1. To configure the controller before wiring the slidewire feedback signal to the controller, complete these steps:
    a. Go to the CONTROL menu.
    b. Set a value for PV BREAK
    c. Go to the SPECIAL menu.
    d. Set a value for DES. OUTPT.
    e. Set a value for PWR.UP:OUT.
    f. Go to SER. COMM. menu.
    g. Set a value for SHED OUT.
2. Place the controller under manual control.
3. Go to the CONFIG. menu.
4. Set either LOOP1 OUT or LOOP2 OUT to POS. PROP (position proportioning).
5. Set SLIDEWIRE to LOOP1 or LOOP2.
6. Go to the CONTROL menu.
7. For S/W RANGE, specify the full range resistance of the slidewire from end-to-end. With a 100 ohm slidewire, this parameter should be set to 100.
8. Scroll to OPEN F/B (Open feedback). Enter the ohm value when the actuator is fully open (0 to 1050 ohms).
9. Scroll to CLOSE F/B (Closed feedback). Enter the ohm value when the actuator is fully closed (0 to 1050 ohms).
10. Measure the actual slidewire value at the terminals (10 and 11).

    As an alternative, set up these two parameters dynamically. Before entering Set Up set the manual output at 100%. Enter Set Up and change the OPEN F/B value until the actuator just reaches its full open position.

    Exit Set Up and set the manual output to 0%. Enter configuration and change the CLOSE F/B value until the actuator just reaches its full closed position.
11. Set the parameter P. PROP. D.B., which is used to eliminate cycling of the motor. A low deadband setting may result in motor overspin or cycling. A high deadband will result in reduction of sensitivity. To set:
    a. Go to the TUNING menu.
    b. Set P. PROP. D.B. to .5%.
    c. Place controller under Manual control.

CAUTION!
The relay in socket 1 drives the motor counterclockwise and the relay in output socket 2 drives the motor clockwise.
This is important for:
- Wiring the outputs
- Selecting the control ACTION:1 parameter, or
- Determining the normally open or normally closed relays.

The configuration choices influence the way the position proportioning algorithm works.

NOTE: OPEN F/B and CLOSE F/B values are always reference to the CCW end of the Slidewire.

NOTE: P.PROP.D.B. can only be configured if the Slidewire Feedback is wired to the controller.

d. Change the output percentage and observe if the valve stabilizes at the new value.
e. If the valve oscillates, increase the P.PROP.D.B. value by 0.5%; repeat until oscillation stops.

E. VELOCITY POSITION PROPORTIONING CONTROL

Velocity position proportioning does not utilize direct feedback. It estimates the position of the actuator, based on time and the speed of the actuator.

NOTE: Adaptive tuning is not available with velocity position proportioning control.

In automatic control mode, the controller will display "CW" to refer to energizing of the clockwise relay, and "CCW" to refer to energizing of the counterclockwise relay. A blank display means that both relays are de-energized.

In manual control mode, the display is blank unless an output change is being made. Use the ▲ and ▼ keys to change the output; the relay is only energized while the keys are being pressed. The display indicates the percentage change in valve position in real time. The rate of change is dependent on the values entered for **CCW TIME** and **CW TIME**.

The controller will transfer to manual control due to a lost process variable (**PV. BREAK**), a digital input closure (**DES.OUTPT.**), a power-up sequence (**PWR.UP:OUT.**), or lost communications (**SHED OUT**). In these cases, the output can be set to: remain at its last value with both relays de-energized (OUTS OFF); rotate fully counterclockwise (CCW); or rotate fully clockwise (CW). CCW and CW will energize the respective relay for a period two times that of the **CCW TIME** or **CW TIME**.

Hardware Configuration

- The controller must have mechanical relay, solid state relay or DC logic modules installed in the first two output sockets.

Refer to the section on Chapter 1 for more information.

Software Configuration

1. Go to **CONFIG.** menu.

   Set LOOP1 OUT or **LOOP2 OUT** to POS. PROP.
2. Go to the **CONTROL** menu.

   Set **SLIDEWIRE** to NONE. Alternatively, set **SLIDEWIRE** to LOOP1 or LOOP2, whichever does NOT have velocity position proporioning on it.
3. Set **CCW TIME** to the amount of time (in seconds) it takes for the actuator to fully rotate in the counterclockwise direction.

   Set **CW TIME** to the amount of time (in seconds) it takes for the actuator to fully rotate in the clockwise direction.

   Loads on the valve may affect the time required, therefore, it is best to measure these values when the valve is in service. As an alternative, enter the values specified by the actuator manufacturer and then make adjustments later.
4. Set **MIN. TIME** to the minimum amount of time the controller must specify for the motor to be on before it takes any action.
5. Set values for **PV. BREAK, DES. OUTPT., PWR.UP:OUT.** and **SHED OUT.**

F. STAGED OUTPUTS

With staged outputs, one analog output can vary its signal (e.g., 4-20 mA) over a portion of the PID output range. The second analog output then varies its signal over another portion of the PID output range. This is an excellent method to stage two control valves or two pumps using standard control signal ranges.

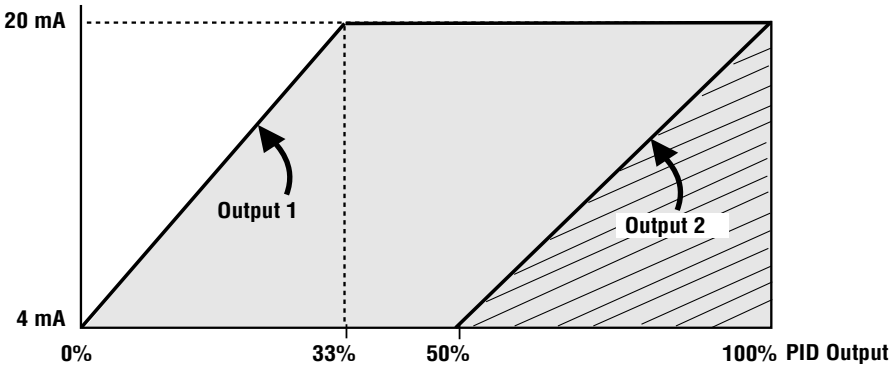


Figure 7.10
Staged Outputs Example
OUT1 STOP was set to 33% and OUT2 STRT. was set to 50%.

Hardware Configuration

- The controller must have analog output modules installed in the first two output sockets.

Software Configuration

1. Go to the **CONFIG.** menu.
   Set **CTRL. TYPE** to STAGED.
2. Go to the **CONTROL** menu.
3. For **OUT1 STOP**, specify where the first output reaches 100%.
4. For **OUT2 START**, specify where the second output begins.

G. RETRANSMISSION

The retransmission feature may be used to transmit a milliamp signal corresponding to any of the following values: PV, SP1, Ramp SP1, Out L1, PV2, SP2, Ramp SP2, OUTL2. A common application is to use it to record one of these variables with a recorder.

NOTE:
For an analog output module for retransmission that was not factory-installed, calibrate the output for maximum accuracy. Refer to Appendix 4 for details on calibration.

Hardware Configuration

- There must be an analog module installed in output socket 2, 3 or 4.

Software Configuration

Up to two outputs can be configured for retransmission. The menu will scroll through the configuration parameters for specified value “X” (2, 3 or 4).

1. Go to the **CONFIG.** menu.
2. For **OUTPUT:2, OUTPUT:3** and **OUTPUT:4** parameters, set one or two of them to RETRANS.
3. Go to the **RETRANS.** menu.
4. Set the corresponding parameter, **TYPE:X**, for the first retransmission output to define what is being transmitted: the process variable, setpoint, ramping setpoint or output.

5. Set parameters LOW RANGE:X and HIGH RANGE:X for the first retransmission output, to define the range of the transmitted signal in engineering units. This can be useful in matching the input range of the receiving device.
6. For any other retransmission output, continue to scroll through the this menu and set the TYPE:X, LOW RANGE:X and HIGH RANGE:X for the second retransmission output.

H. DIGITAL INPUTS

Digital inputs can be activated in three ways: A switch (signal type)—the recommended type, a relay, or and open collector transistor

Digital inputs are only functional when that option is installed (via hardware). The controller detects the hardware type, and supplies the appropriate software menus (see the section on parameters in Chapter 5). There are 14 contact types for the five digital inputs.

Hardware Configuration

- This optional feature is only available if ordered originally from the factory, Product #545xxxxxxDx00. The five digital inputs share a common ground.

Software Configuration

1. Go to the CONFIG. menu.
2. Set parameters **CONTACT:1** through **CONTACT:3** (only those available will shown) by assigning the desired function to each output. Choices are:

NOTE: To take advantage of multiple setpoints, make sure that the SP NUMBER parameter in the **SPECIAL** menu is set to a value greater than 1.

- **L1.SP.1-4**

  (**CONTACT:1** only) Allows the controller to use the digital inputs 1 and 2 to select a setpoint for Loop 1 (see Figure 7.11). If the state of these inputs remains constant, the controller will continue to use the selected setpoint unless overridden. Override the set of digital inputs by selecting a different setpoint (by using **SET PT** key or through communications), or by using the fifth digital input to select the remote or 2nd setpoint. To "rearm" this set of digital inputs, the DIN combination must change.

Setpoints	DIN 1	DIN 2	DIN 4	DIN 5
Loop 1 SP1	0	0		
Loop 1 SP2	X	0		
Loop 1 SP3	0	X		
Loop 1 SP4	X	X		
Loop 2 SP1			0	0
Loop 2 SP2			X	0
Loop 2 SP3			0	X
Loop 2 SP4			X	X

Figure 7.11
Combinations of Closed Digital Inputs for Each Setpoint (based on BCD logic)
X=closed contact
0=open contact

- **L1.REM.SP.**

  Closing input changes active setpoint to remote setpoint. Opening reverts controller to previous setpoint. Override by selecting a different setpoint via the **SET PT** key, a communications command, or other digital inputs.

- **L1. MAN.**

  Closing input trips the controller to manual. Opening input reverts controller to automatic. Override by using **MANUAL** key, a communications command, or "trip to automatic" function.

- **L1. 2ND. SP.**

  Closing input changes active setpoint to the 2nd local setpoint. Opening input reverts controller to previous setpoint digital input. Override by selecting a different setpoint via the **SET PT** key, a communications command, or other digital inputs.

- **L1. 2ND. PID.**

  Closing input changes active set of PID values to 2nd set. Opening input bases active set of PID on rules defined in **PID TRIP** and **TRIP:1** to **TRIP:8.** Override input only by directly linking PID set to the active setpoint and changing the active setpoint.

- **L1.ALARM ACK.**

  Closing input acknowledges all active alarms. Opening input "rearms" the controller. If the digital input remains closed, it *does not* continue to immediately acknowledge alarms as they become active.

- **L1. RSP. INH.**

  Reset Inhibition. Closing input deactivates "I" (integral) term, regardless of the PID values being used. Opening input activates "I" term (if applicable).

- **L1. D.A./R.A.**

  Direct Acting/Reverse Acting. Closing input reverses action of the first control output (from direct to reverse, or reverse to direct). Opening reinstates original action.

- **L1. NO A/T**

  Closing input temporarily disables Adaptive Tuning. Opening input enables it.

- **L1. LCK. MAN**

  Closing contact places the controller in manual control at the designated output percentage. All locked manual contacts must be opened in order to return controller to automatic control.

- **UP KEY**

  Closing the contact mimics the ▲ key. Useful if controller is mounted behind a window; contact push-buttons can be used to change setpoint values.

- **DOWN KEY**

  Closing the contact mimics the ▼ key. Useful if controller is mounted behind a window; contact push-buttons can be used to change setpoint values.

- **DISP. KEY**

  Closing contact mimics the **DISPLAY** key; scroll through display of the Setpoint, Deviation % and Output %.

- **FAST KEY**

  Closing contact mimics the **FAST** key . Use in conjunction with ▲, ▼, **DISPLAY** and **MENU** keys.

NOTE: The second display does not change when tripping to manual from a closed digital input.

NOTE: Only alarms configured to be acknowledged are affected by this digital input.

- **MENU KEY**

  Closing contact mimics the **MENU** key. In OPERATION Mode, provides entry to **TUNING** menu. **In SET UP** or **TUNING** Mode, advances through the menus.
- **COMM. ONLY**

  Makes input status readable through communications (but has no effect on the controller itself).

3. Set parameters **CONTACT:4** and **CONTACT:5** (only those available will be shown) by assigning the desired function to each output. Choices are:
   - **L2.SP.1-4**

     (**CONTACT:4** only) Allows the controller to use the digital inputs 4 and 5 to select a setpoint for Loop 2 (see Figure 7.11). If the state of these inputs remains constant, the controller will continue to use the selected setpoint unless overridden. Override the set of digital inputs by selecting a different setpoint (by using **SET PT** key or through communications), or by using the fifth digital input to select the remote or 2nd setpoint. To "rearm" this set of digital inputs, the DIN combination must change.
   - **L2.REM.SP.**

     Closing input changes active setpoint to remote setpoint. Opening reverts controller to previous setpoint. Override by selecting a different setpoint via the **SET PT** key, a communications command, or other digital inputs.
   - **L2. MAN.**

     Closing input trips the controller to manual. Opening input reverts controller to automatic. Override by using **MANUAL** key, a communications command, or "trip to automatic" function.
   - **L2. 2ND. SP.**

     Closing input changes active setpoint to the 2nd local setpoint. Opening input reverts controller to previous setpoint digital input. Override by selecting a different setpoint via the **SET PT** key, a communications command, or other digital inputs.
   - **L2. 2ND. PID.**

     Closing input changes active set of PID values to 2nd set. Opening input bases active set of PID on rules defined in **PID TRIP** and **TRIP:1** to **TRIP:8**. Override input only by directly linking PID set to the active setpoint and changing the active setpoint.
   - **L2.ALARM ACK.**

     Closing input acknowledges all active alarms. Opening input "rearms" the controller. If the digital input remains closed, it *does not* continue to immediately acknowledge alarms as they become active.
   - **L2. RSP. INH.**

     Reset Inhibition. Closing input deactivates "I" (integral) term, regardless of the PID values being used. Opening input activates "I" term (if applicable).

- **L2. D.A./R.A.**

  Direct Acting/Reverse Acting. Closing input reverses action of the first control output (from direct to reverse, or reverse to direct). Opening reinstates original action.
- **L2. NO A/T**

  Closing input temporarily disables Adaptive Tuning. Opening input enables it.
- **L2. LCK. MAN**

  Closing contact places the controller in manual control at the designated output percentage. All locked manual contacts must be opened in order to return controller to automatic control.
- **UP KEY**

  Closing the contact mimics the ▲ key. Useful if controller is mounted behind a window; contact push-buttons can be used to change setpoint values.
- **DOWN KEY**

  Closing the contact mimics the ▼ key. Useful if controller is mounted behind a window; contact push-buttons can be used to change setpoint values.
- **DISP. KEY**

  Closing contact mimics the **DISPLAY** key; scroll through display of the Setpoint, Deviation % and Output %.
- **FAST KEY**

  Closing contact mimics the **FAST** key . Use in conjunction with ▲, ▼, **DISPLAY** and **MENU** keys.
- **MENU KEY**

  Closing contact mimics the **MENU** key. In **OPERATION** Mode, provides entry to **TUNING** menu. In **SET UP** or **TUNING** Mode, advances through the menus.
- **COMM. ONLY**

  Makes input status readable through communications (but has no effect on the controller itself).

Basic Operating Procedures

1. If more than one digital input closes and their actions conflict, the last digital input that closed has priority.

   For example, if one digital input closes and selects 2nd setpoint, and then another digital input closes and selects a remote setpoint, the remote setpoint takes precedence.
2. Any digital input can be overridden by: another digital input, a keyboard operation, or an automatic function. If a closed digital input is overridden, then it must be opened in order to be rearmed.

   For example, if one digital input closes and selects the 2nd setpoint, and then a different setpoint is selected through the keyboard, the keyboard selection takes precedence.

I. REMOTE SETPOINT

The Remote Setpoint can be assigned to Loop 1, Loop 2, or both. Remote setpoint limits are the same as setpoint limits.

Hardware Configuration

- This optional feature is available only if ordered originally from the factory, Product #545-xxxxxBxx00 or #545-xxxxxExx00). Refer to the order code in Chapter 1.
- Before configuring the software, make sure the corresponding jumper is set properly. Refer to Chapter 4 to check or change jumper positions.

NOTE: There is a one-second delay before a closed digital input takes action.

Software Configuration

1. Go to the **REM. SETPT.** menu.
2. Set **TYPE V/mA** to define the input signal range (e.g. 4-20mA).
3. **RSP:LO. RNG.** and **RSP: HI RNG.** define the range of the remote setpoint in engineering units. The correct range will be dependent on the source of the remote setpoint signal.
4. **RSP:LOW** and **RSP:HIGH** set limits on the remote setpoint value in engineering units.
5. **TRACKING** determines whether or not the controller will revert to a local setpoint if the remote setpoint signal is lost. This prevents a process upset due to a sudden change in setpoint.
6. **BIAS LOW** and **BIAS HIGH** set limits on an operator entered bias value.
7. **RSP FIXED** determines the signal to which the controller will revert when a lost RSP is restored (fixed). Options are to stay in local or automatically return to remote setpoint.
8. To bias or ratio the remote setpoint value:
    a. Go to the **TUNING** menu.
    b. Set **RSP BIAS** and **RSP RATIO** values.

Basic Operating Procedures

After configuring the hardware and software, select the remote input by:

- pressing the **SET PT** key until RSP shows in the display
- using a digital input

J. MULTIPLE SETPOINTS

The 545 can store up to eight local setpoints and use a remote setpoint. One application of this feature is configuring the controller to restrict operators to discrete setpoint choices. The 545 can also store multiple sets of PID parameters (see next section).

Software Configuration

1. Go to the **SPECIAL** menu.
2. Set **NO. OF SP** to the number of local setpoints desired.
3. Use the **SET PT** key to scroll to each local setpoint and set it to the desired value with the ▲ or ▼ keys.
4. To link the PID sets to the corresponding local setpoint:
   Go to the **TUNING** menu.

Set **NO. OF PID** to SP NUMBER.

For details on multiple sets of PID, refer to the next section in this chapter.

Basic Operating Procedures

To select a set point, toggle the **SET PT** key to scroll through the setpoints. The displayed setpoint becomes active after two second of key inactivity.

The digital inputs can also be used to select the active setpoints. A single digital input may be used for selecting the seconds setpoint, SP2. A set of two digital inputs per loop may be used, to select up to 4 setpoints per loop (see the section in this Chapter in Digital Inputs).

The **SET PT** key is lit when a setpoint other than the primary local setpoint is active.

K. MULTIPLE SETS OF PID VALUES

The 545 has the ability to store up to eight sets of PID values. This can be a valuable feature for operating the controller under conditions which require different tuning parameters for optimal control. There are various methods of selecting which set should be active. These methods are explained in this section.

Software Configuration

1. Go to the **TUNING** menu.
2. **NO.OF PID** is the desired number of PID sets to be stored. SP NUMBER automatically sets this value equal to the number of stored local setpoints (each PID set will be active when its respective local setpoint is active).
3. **PID TRIP** determines which variable selects the various PID sets: process variable, setpoint or deviation from setpoint.
4. **TRIP:X** defines the point (in the PV range) at which that set of PID values become active.

Basic Operating Procedures

A PID set can be selected in one of four ways.

- For **NO. OF PID** = SP NUMBER, the active set of PID values is the same as the active setpoint. For example, if SP3 is active, then PID set #3 will be active.
- When using PID trip values, a PID set becomes active when the variable exceeds its trip point.

  For example, if **PID TRIP** = SETPOINT, and **TRIP:2** = 500, the second set of PID values becomes active when the setpoint exceeds 500, and remains active until the setpoint drops below 500 or exceeds the next highest trip point. The PID set with the lowest trip point is also active when the trip variable is less than the trip value. (The user can set the lowest trip point = the low end of the process variable range, but this is not required.)
- A digital input can be set to trip to the second set of PID upon closure, which overrides a selection based on trip points.

Using with Adaptive and Pretune

The 545 can be programmed to automatically set the PID values using the Pretune and Adaptive Tuning functions. For both functions, the tuned set of PID is that which is active upon initiation of the tuning function.

The controller cannot trip to other PID sets (based on trip point or the digital input

contact) until Adaptive Tuning is disabled. However, if the PID set is tied to the corresponding local setpoint, the active PID set values will change with the local setpoint.

Each PID set has 5 parameters that control its function—proportional band, reset, rate, manual reset (or loadline), and trip point. For each set (2 thru 8), these values have to be manually set.

1. Press **MENU** to access the **TUNING** menu.
2. Set values for parameters 1 thru 20 (these include the first PID set)
3. Press **MENU** to access these parameters for each additional PID set (2 through 8): **PROP. BND, RESET, RATE, MAN. RST**. and **TRIP**.

L. POWERBACK

POWERBACK is Moore Industries' proprietary algorithm which, when invoked by the user, reduces or eliminates setpoint overshoot at power up or after setpoint changes. Powerback monitors the process variable to make predictive adjustments to control parameters, which in turn helps to eliminate overshoot of the Setpoint.

Software Configuration

1. Go to the **TUNING** menu.
2. Set **POWR.BACK** parameter to ENABLED.
3. Go to the **SELF TUNE** menu.
4. The **DEAD TIME** is the time between initiation of an input change and the start of an observable response in the process variable. Pretune will automatically calculate a value for this parameter. However, if Pretune is not run, or results are poor, value choices are:
   R 10 to 3200 seconds
   D 7200 seconds

M. SELF TUNE—POWERTUNE®

The Self Tune function of the 545 consists of two distinct components, Pretune and Adaptive Tune. These components may be used independently or in conjunction with one another. For best results, we recommend using them together.

Pretune

This algorithm has three versions. Choose the type that most closely matches the process to optimize the calculation of the PID parameters. The three Pretune types are:

- TYPE 1 Normally used for slow thermal processes
- TYPE 2 Normally used for fast fluid or pressure processes
- TYPE 3 Normally used for level control applications

Pretune is an on-demand function. Upon initiation, there is a five second period during which the controller monitors the activity of the process variable. Then the control output is manipulated and the response of the process variable is monitored. From this information, the initial Proportional Band, Reset and Rate (P, I and D values) and Dead Time are calculated. When using TYPE 2 or TYPE 3 Pretune, the Noise Band (**NOISE BND.**) and Response Time (**RESP. TIME**) and DEAD TIME will also be calculated.

In order to run this algorithm, the process must fulfill these requirements:

- The process must be stable with the output in the manual mode;
- For tuning a non-integrating process, the process must be able to reach a stabilization point after a manual step change; and
- The process should not be subject to load changes while Pretune operates.

If these conditions are not fulfilled, set the Adaptive Tune to run by itself.

Adaptive Tune

Adaptive Tune continuously monitors the process and natural disturbances and makes adjustments in the tuning parameters to compensate for these changes. In order to make accurate calculations, Adaptive Tune needs noise band and response time values. Pretune TYPE 2 and TYPE 3 automatically calculate these values. These values may also be entered or changed manually in the **SELF TUNE** menu. For Pretune TYPE 1, Noise Band, Response Time and Dead Time parameters must be entered manually.

Figure 7.12 illustrates the relationship between Pretune and Adaptive Tune

CAUTION!

Disable Adaptive Tuning before altering process conditions (e.g., for shutdown, tank draining, etc.). Otherwise, the 545 will attempt to adapt the Tuning parameters to the temporary process conditions.

Adaptive Tune can be disabled via digital input (if applicable—see Digital Inputs in this chapter), or via menus:

1. Go to the **TUNING** menu.
2. Go to parameter **ADAPTIVE**. Change the value to **DISABLED**.

Software Configurations

Pretune by Itself

1. Go to the **SELF TUNE** menu (press **MENU+FAST**)
2. Set the **TYPE** parameter to PRETUNE.
3. Set the **PRETUNE** type to the one that best matches the process (see above section).
4. The next parameter, **TUNE PT**., appears only for TYPE 1 pretune. This parameter sets the PV point at which the output will switch off. In thermal processes, this will help prevent overshoot. The default is **AUTOMATIC**.
5. Set the value for **OUT STEP.** This parameter defines the size of bump to be used. The resulting disturbance must change the process variable by an amount that significantly exceeds the peak-to-peak process noise, but does not travel beyond the “normal” process variable range.
6. The next two parameters, **LOW LIMIT** and **HI LIMIT**, set the process variable boundaries. If these boundaries are exceeded during the Pretune, the pretune cycle will abort and return to manual control at the output level prior to the initiation of pretune.
7. The next parameter, **TIMEOUT**, defines the maximum time in minutes within which pretune must complete its calculations before it is aborted.

   The first time a pretune is performed, set **TIMEOUT** to its maximum value. Make note of the length of the pretune cycle. Then, adjust **TIMEOUT** to a value about twice the pretune time.

   The purpose of this parameter is to prevent a Pretune cycle from continuing for an excessive period of time if a problem develops. The value has no impact on the PID values being calculated.
8. Next is **MODE**. This defines what mode the controller will enter when pretune is completed. Select MANUAL if there will be a need to review PID parameters before attempting to control with them; the default is AUTOMATIC.
9. If **POWERBACK** algorithm is being utilized, set a value for **DEAD TIME**.
10. Place the controller under manual control.

11. Access the **TUNING** menu (press **MENU**).
    Set the first parameter, **ADAPTIVE**, to DISABLED.
12. Activate the next parameter, **PRETUNE.**
13. Press **ACK** to begin Pretuning.
    The 3rd display will show the message EXECUTING.
14. When Pretune is complete, the 3rd display will show COMPLETED for two seconds and then return to the current menu display.

Pretune TYPE 1 & Adaptive Tune

1. Go to the **SELF TUNE** menu.
2. Set **TYPE** to BOTH.
3. Set **PRETUNE** to TYPE 1.
4. Set a value for **TUNE PT**.
5. Set **NOISE BND** parameter.
6. Set the **RESP. TIME** parameter.
7. Make sure that the process is reasonably stable and place the controller under manual control.
8. Press **MENU** to access the **TUNING** menu.
   Set **ADAPTIVE** to ENABLED. The Adaptive Tuning cycle does not begin until the controller is under automatic control.
9. Activate the next parameter, **PRETUNE**.
10. Press **ACK** to begin Pretuning.
    The 3rd display will show the message EXECUTING.
11. When Pretune is complete, the 3rd display will show COMPLETED for two seconds and then return to the current menu display.

The controller will automatically transfer to automatic control upon completion of Pretune if set to do so, or upon manual transfer.

Figure 7.12 illustrates the operation of Pretune TYPE 1 with Adaptive Tune.

Pretune TYPE 2 or 3 & Adaptive Tune

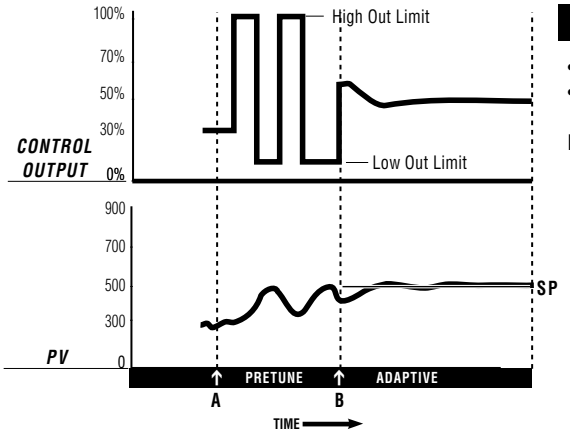
1. Go to the **SELF TUNE** menu.
2. Set the **TYPE** parameter to BOTH.
3. Set the **PRETUNE** parameter to TYPE 2 or TYPE 3.
4. Set the value for **OUTSTEP**.
5. DO NOT Enter values for **NOISE BND, RESP TIME** and **DEAD TIME**. The Pretune algorithm should calculate these values.
6. Make sure that the process is reasonably stable and place the controller under manual control.
7. Press **MENU** to access the **TUNING** menu.
8. Set parameter **ADAPTIVE** to ENABLED. The Adaptive Tuning cycle does not begin until the controller is under automatic control.
9. Activate the next parameter, **PRETUNE**.
10. Press **ACK** to begin Pretuning.
    The 3rd display will show the message EXECUTING.

11. When Pretune is complete, the 3rd display will show COMPLETED for two seconds and then return to the current menu display.

The controller will automatically transfer to automatic control upon completion of Pretune if set to do so, or upon manual transfer.

Figure 7.12 illustrates the operation of Pretunes TYPE 2 and TYPE 3 with Adaptive Tune.

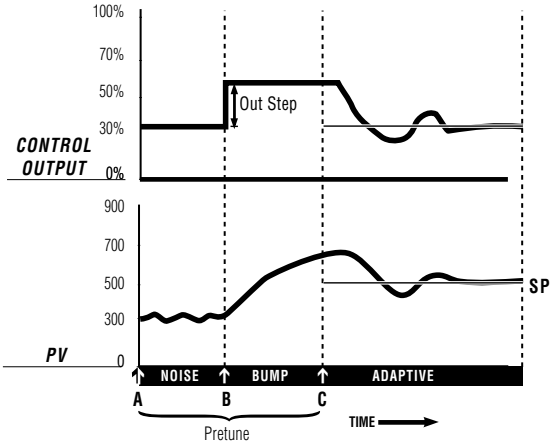
Figure 7.12
Pretune TYPE 1, 2 and 3 with Adaptive Tune



TYPE 1 Pretune/Adaptive Control

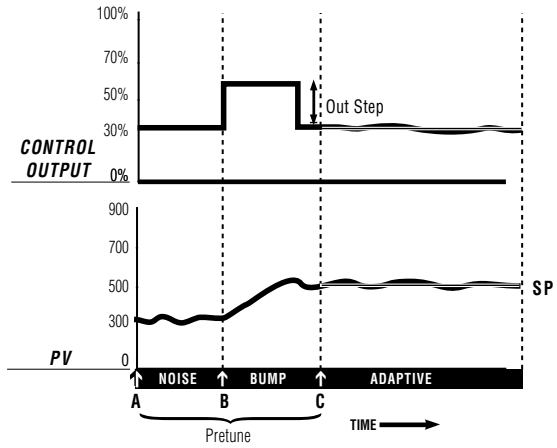
- A to B is ON/OFF control to determine initial PID values.
- B is Pretune completed, so Adaptive PID control beings if ENABLED.

Note: Noise Band and Resp. Time must be entered before enabling Adaptive TUne)



TYPE 2 Pretune/Adaptive Control

- A to B is a 5 second noise band measurement.
- B to C is an open loop bump test to determine initial PID values and response time.
- C is Pretune completed, so Adaptive PID control begins if ENABLED.



TYPE 3 Pretune/Adaptive Control

- A to B is a 5 second noise band measurement.
- B to C is an impulse to determine initial PID values and response time.
- C is Pretune completed, so Adaptive PID control begins if ENABLED.

NOTE: Adaptive tuning is **not** available for velocity position proportional control.

Adaptive Tune by Itself

1. Go to the **SELF TUNE** menu.
2. Set the TYPE parameter to ADAPTIVE.
3. Press **MENU** to access the TUNING menu.
4. Set the ADAPTIVE parameter to ENABLED. The Adaptive Tuning cycle does not begin until the controller is under automatic control.

CAUTION!
If the process conditions are temporarily changed, (e.g., during process shutdown, draining of a tank, etc.) **disable adaptive tuning.**
Otherwise, the controller will attempt to adapt its tuning parameters to the temporary process conditions.
Disable adaptive tuning by:
1. In the TUNING menu, change ADAPTIVE to DISABLED through the keypad; or
2. Closing the appropriate digital input (see Digital Input section in this chapter).

Poor Pretune Results

If Pretune results are poor, or process conditions do not allow Pretune to run, the POWERBACK and Adaptive Tune parameters can be manually configured. Proper setting of the noise band and response time parameters will yield excellent adaptive control without running the Pretune function.

1. Go to the **SELF TUNE** menu.
2. Set **NOISE BND**.

   The noise band is chosen to distinguish between disturbances which affect the process and process variable "noise." The controller functions to compensate for disturbances (i.e., load changes), but it cannot compensate for process noise. Attempting to do this will result in degraded controller performance. The Noise Band is the distance the process deviates from the setpoint due to noise in percentage of full scale.

   Figure 7.13 shows a typical process variable response in a steady-state situation. In this example, the process noise is within a band of about 0.5% of full scale.

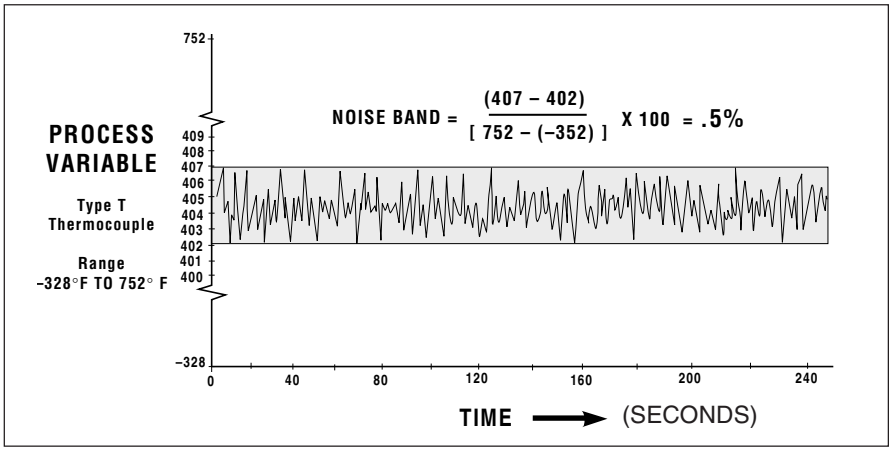


Figure 7.13
Noise Band Calculation Example

A noise band that is too small will result in tuning parameter values based on noise rather than the effects of load (and setpoint) changes. If the noise band is set too small, then Adaptive Tune will attempt to retune the controller too often. This may result in the controller tuning cycling between desirable system tuning and overly sluggish tuning. While the result may be better than that achieved with a non-adaptive controller, this frequent retuning is not desirable.

If the noise band is set too large, the process variable will remain within the noise band, and the controller will not retune itself. With too large a noise band, important disturbances will be ignored, and the controller will be indifferent to sluggish and oscillatory behavior.

Peak to Peak Noise °F	INPUT TYPE										
	B	E	J	K	N	R/S	T	W/WS	PLATINEL	RTD	0.1°RTD
0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2
3	0.1	0.2	0.2	0.1	0.1	0.1	0.3	0.1	0.2	0.2	0.3
4	0.1	0.2	0.2	0.1	0.1	0.1	0.4	0.1	0.2	0.2	0.5
5	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.1	0.2	0.3	0.6
6	0.2	0.3	0.3	0.2	0.2	0.2	0.6	0.1	0.3	0.3	0.7
7	0.2	0.3	0.3	0.2	0.3	0.2	0.6	0.2	0.3	0.4	0.8
8	0.2	0.4	0.4	0.3	0.3	0.3	0.7	0.2	0.4	0.4	0.9
9	0.3	0.4	0.4	0.3	0.3	0.3	0.8	0.2	0.4	0.5	1.0
10	0.3	0.4	0.4	0.3	0.4	0.3	0.9	0.2	0.4	0.5	1.1

Figure 7.14
Noise Band Values for Temperature Inputs

Noise band settings are generally between 0.1% and 1.0%, with most common settings of 0.2% or 0.3%. Figure 7.14 shows the conversion of peak-to-peak noise to an appropriate noise band for each T/C type & RTD.

3. Set **RESP. TIME**.

   The response time is the most critical value in Adaptive Tuning. Response time represents the time lag from a change in valve position (controller output) to a specific amount of change in process variable. Specifically, Response Time is equal to the Dead time of the process plus one Time Constant. The Dead time is the time between initiation of an input change and the start of an observable response in the process variable. The Time Constant is the interval of time between the start of that observable response and the point where the process variable reaches 63% of its final value. (See Figure 7.15).

   Example

   After a stimulus (e.g., valve movement), if it takes 300 seconds for a process to reach 63% of its new (expected) value, the response time is 300 seconds. If the response time is set too short, the process will be unstable and cycle around the setpoint. If the Response Time is set too long, response to an off-setpoint condition will be sluggish. It is generally better to use a response time that is too long rather than too short.

4. Set **DEAD TIME.**

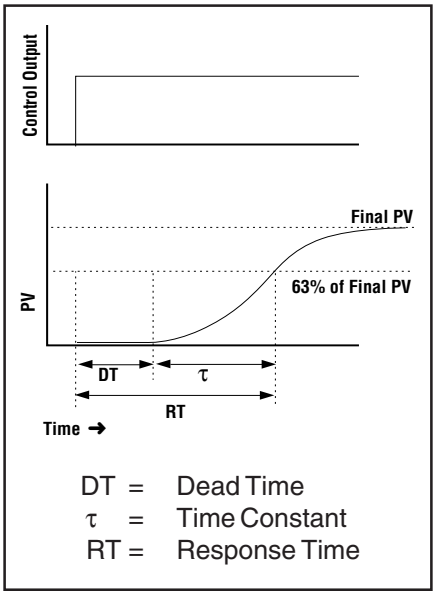


Figure 7.15
Deadtime and Time Constant

Self Tuning with Multiple Sets of PID

For both Pretune and Adaptive Tune, the tuned set of PID is that which is active upon initiation of the tuning function.

The controller cannot trip to other PID sets (based on trip point or the digital input contact) until Adaptive Tuning is disabled. However, if the PID set is tied to the corresponding local setpoint, the active PID set values will change with the local setpoint.

Each PID set has 5 parameters that control its function—proportional band, reset, rate, manual reset (or loadline), and trip point. For each set (2 thru 8), these values have to be manually set.

1. Press MENU to access the **TUNING** menu.
2. Set values for parameters 1 thru 20 (these include the first PID set).
3. Press **MENU** to access these parameters for each additional PID set (2 through 8): **PROP. BND, RESET, RATE, MAN. RST. and TRIP.**

Self Tune with Time Proportioning Outputs

When using either the Pretune or the Adaptive Tune with a time proportioning output, use as short of a cycle time as possible within the constraint of maintaining a reasonable life on relays, contacts or heating elements.

Self Tune with Control Valves

In many systems utilizing a control valve, the point at which the control valve begins to stroke does not coincide with 0% output, and the point at which it completes its stroke doesn't coincide with 100%. The parameters LOW OUT and **HIGH OUT** in the **CONTROL** menu specify the limits on the output. Set these limits to correspond with the starting and stopping point of the valve's stroke. This prevents a form of "windup" and thus provides the adaptive control algorithm with the most accurate information.

For example, in manual, the control output was slowly increased and it was noted that the control valve started to stroke at 18% and at 91% it completed its stroke. In this case **LOW OUT** should be set at 18% and **HIGH OUT** at 91%.

Note that when output limits are used, the full output range from -5 to 105% is available in manual control.

Self Tune with Cascade Control

1. To pretune Loop 2 with a Type 1 pretune, Loop 1 must be under manual control. Otherwise, the controller will display the error message PRETUNE LP1 AUTO.
2. To pretune Loop 1, Loop 2 must be under Automatic Control. Otherwise the controller will display the error message PRETUNE L2 MANUAL.

N. RAMP-TO-SETPOINT

The 545 contains a ramp-to-setpoint function that may be used at the user's discretion. This function is especially useful in processes where the rate-of-change of the setpoint must be limited.

When the ramping function is activated, the controller internally establishes a series of setpoints between the original setpoint and the new **target** setpoint. These interim setpoints are referred to as the **actual** setpoint . Either setpoint may be viewed by the user. When the setpoint is ramping, RAMPING will be shown in the 3rd display when the actual (ramping) setpoint is displayed.

When the target setpoint is being shown, RAMPING will **not** appear. Pressing the **DISPLAY** key will scroll the 2nd display as follows:

- From the target setpoint to the actual (ramping) setpoint;
- To the deviation from setpoint;
- To the output level; and
- Back to the target setpoint.

Note that when ramping, the deviation indication is with respect to the target setpoint.

The ramp-to-setpoint function is triggered by one of three conditions:

1. Upon power up, if the 545 powers up in automatic control, then the setpoint will ramp from the process variable value to the setpoint value at the specified rate.

2. On a transfer from manual to automatic control the setpoint will ramp from the process variable value to the setpoint value at the specified rate.
3. On any setpoint change, the setpoint will ramp from the current setpoint to the new target setpoint. When triggered, the display will automatically change to indicate the ramping setpoint.

Software Configuration

1. Go to the **PV INPUT** menu.
2. Set the **SP RAMP** parameter to the desired rate of change.

O. INPUT LINEARIZATION

Thermocouple and RTD Linearization

For a thermocouple or RTD input, the incoming signal is automatically linearized. The 545 has lookup tables that it uses to provide an accurate reading of the temperature being sensed.

Square Root Linearization

Many flow transmitters generate a nonlinear signal corresponding to the flow being measured. To linearize this signal for use by the 545, the square root of the signal must be calculated. The 545 has the capability to perform this square root linearization.

For the first 1% of the input span, the input is treated in a linear fashion. Then it is a calculated value, using the formula in Figure 7.16.

$$\mathbf{PV = Low\ Range + \left[(Hi\ Range - Low\ Range) \sqrt{(V_{input} - V_{low} / (V_{high} - V_{low})} \right]}$$

Hi Range is the high end of the process variable.
Low Range is the low end of the process variable.
$\mathbf{V_{input}}$ is the actual voltage or current value of the input.
$\mathbf{V_{high}}$ is the high end of the input signal range (e.g. 5 volts or 20 mA).
$\mathbf{V_{low}}$ is the low end of the input signal range (e.g. 1 volt or 4 mA).

Example:
PV range is 0 – 1000.
Input signal range is 1–5 volts.
Input signal is 3 volts.

Therefore $PV = 0 + \left[(1000 - 0) \sqrt{(3\text{-}1) / (5\text{–}1)} \right] = 1000 \sqrt{.5} = \mathbf{707}$

Figure 7.16
Square Root Linearization Formula

Hardware Configuration

- A voltage or milliamp input must be installed on the controller.

Software Configuration

1. Go to the **PV INPUT** menu.
2. Set **LINEARIZE** to SQR. ROOT.

Custom Linearization

Custom linearization allows virtually any nonlinear signal to be linearized using a 15-point straight line approximation curve (see Figure 7.17). Typical applications are linearizing signals from nonlinear transducers, or controlling volume based on level readings for irregularly-shaped vessels. To define the function, enter data point pairs—the engineering units corresponding to a particular voltage or current input.

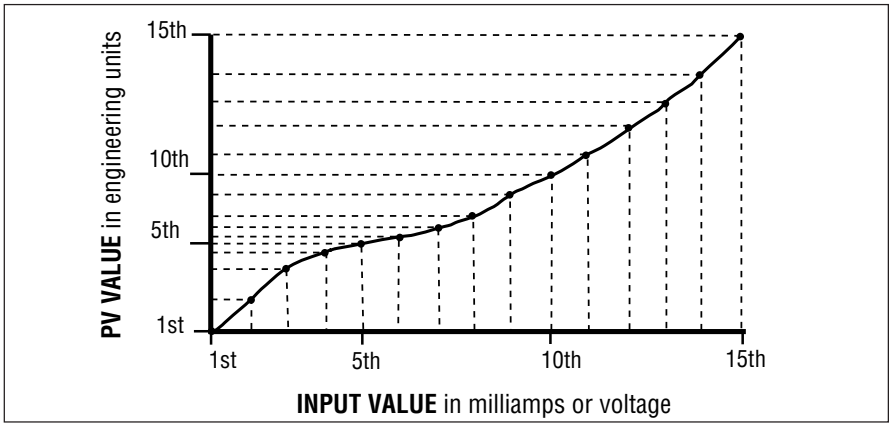


Figure 7.17
15-point Linearization Curve

Software Configuration

1. Go to the **PV INPUT** menu.
2. Set the parameter **LINEARIZE** to CUSTOM.
3. Go to the **CUST. LINR**. menu.
4. Enter values for the **1ST INPUT** and **1ST PV** data points. All the input parameters define the actual milliamp or voltage input. All the PV parameters define the corresponding process variable value in engineering units.

It is not necessary to use all 15 points. Whenever the **XTH INPUT** becomes the high end of the input range, that will be the last point in the table.

Once the various points are defined, the values between the points are interpolated using a straight line relationship between the points. The only limitation is that the resulting linearization curve must be either ever-increasing or ever-decreasing.

P. LOAD LINE

Load line is a manual reset superimposed on the automatic reset action. Adjusting the **MAN. RST.** tuning constant shifts the controller proportional band with respect to the setpoint.

When used with a proportional only or proportional/derivative control algorithm, the **MAN. RST.** parameter (located in the **TUNING** menu) is in effect “manual reset”.

However, when the automatic reset term is present, the reset action gradually shifts the proportional band to eliminate offset between the setpoint and the process. In this case, load line provides an initial shift at which the reset action begins. Load line is adjusted by observing the percent output required to control the process and then adjusting the load line to that value. This minimizes the effect of momentary power outages and transients. Load line may also be

adjusted to give the best response when bringing the load to the desired level from a “cold” start.

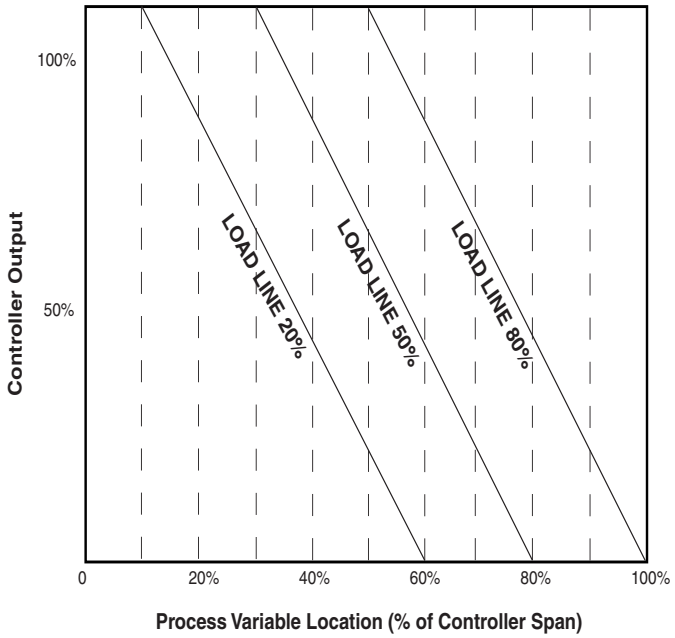


Figure 7.18
Load Line Example

Q. SECURITY

The 545 security system is easily customized to fit a system’s needs.

Software Configuration

1. Go to the **SECURITY** menu.
2. **SEC. CODE** defines the security password (range from -9999 to 99999). The rest of the security parameters can be selectively locked out.
3. **SP ADJUST** prevents the operator from using the ▲ and ▼ keys to change the setpoint value. It does not prevent the operator from changing setpoints via the **SET PT** key.
4. **AUTO./MAN.** locks out the **MANUAL** key, preventing the operator from transferring between automatic control and manual control.
5. **SP SELECT** locks out the **SET PT** key. This prevents the operator from changing among the various local setpoints or changing to remote setpoint. It does not prevent the operator from changing the setpoint value via the ▲ and ▼ keys.
6. **ALARM ACK.** locks out the **ACK** key, preventing an operator from acknowledging any alarms.
7. **TUNING** locks out modification to the parameters in the **TUNING** menu, preventing unauthorized changes to the tuning parameters or the activation/ deactivation of the self tuning algorithm.
8. **CONFIGURE** allows access to the configuration menus, but prevents any unauthorized changes to the configuration parameters. If locked out, the security code is not accessible.

NOTE: SEC CODE does not appear unless all functions are unlocked.

NOTE: Lock out **CONFIGURE** for full security. If left unlocked, the operator will have access to the security code.

NOTE: The security function is compromised if the security code is left at zero (0).

Basic Operating Procedures

The security feature can be overridden. When a locked function is attempted, the operator will have the opportunity to enter the security code. **If the correct security code is entered, the operator has full access. The security feature is reactivated after one minute of keypad inactivity.** If the security code is forgotten, the security feature can still be overridden.

NOTE: Security does not prevent the operation from the digital inputs or serial communications.

- The security override code is **62647**.

  Store this number in a secure place and blacken out the code in this manual to limit access.

R. RESET INHIBITION

Reset Inhibition is useful in some systems either at the start-up of a process or when a sustained offset of process variable from setpoint exists. In conditions like these, the continuous error signal may cause the process temperature to greatly overshoot setpoint. Any of the digital inputs may be set up so that the contact closure disables the reset action (sets it to zero).

Software Configuration

1. Go to the **CONFIG**. menu.
2. Set corresponding parameter(s) **CONTACT:1** to **CONTACT:5** to RST. INHBT.

S. PROCESS VARIABLE READING CORRECTION

Conditions extraneous to the controller—an aging thermocouple, out of calibration transmitter, lead wire resistance, etc.—can cause the display to indicate a value other than the actual process value. The **PV OFFSET** and **PV GAIN** parameters can be used to compensate for these extraneous conditions. NOTE: This feature is provided as a convenience only. Correcting the cause of the erroneous reading is recommended.

1. Go to the PV INPUT menu.
2. Set **PV OFFSET.** This parameter either adds or subtracts a set value from the process variable reading in engineering units. For example, if the thermocouple was always reading 3° too high, the parameter could be set to "–3" to compensate.
3. Set **PV GAIN.** This multiplies the deviation from the low end of the process variable range by the gain factor and then adds it to the value of the low end of the range to arrive at the adjusted process variable value.

   For example, if the process variable range is 50 to 650 and the process variable reading is 472, a **PV GAIN** of .995 would yield an adjusted process variable equal to [(472 – 50) x .995] + 50 = 470.

NOTE: PV GAIN is only available if using a linear voltage or current input.

With a combination of both offset and gain factors, just about any inaccuracy in the sensor or transmitter can be compensated.

T. SERIAL COMMUNICATIONS

The serial communications option enables the 545 to communicate with a supervisory device, such as a personal computer or programmable logic controller.

The communications standard utilized is RS-485 which provides a multi-drop system that communicates at a high rate over long distances. Typical limitations are 32 instruments per pair of wires over a distance up to 4000 feet.

The 545 uses a proprietary protocol which provides an extremely fast and accurate response to any command. Cyclic redundancy checking (CRC) virtually ensures the integrity of any data read by the 545. Through communications, there is access to every Set up, Tuning and Operating parameter. For details on 545 protocol, contact a Moore Industries' application engineer.

Hardware Configuration

- This optional features is only available if ordered originally from the factory. The circuitry for communications is contained on a modular circuit board that plugs into the Microcontroller Circuit Board, Refer to the order code in Chapter 1 for details.

Software Configuration

1. Access the **SER. COMM**. menu.
2. **STATION** specifies the unit's station address. It is the only way one 545 can be distinguished from another. Each 545 on the same RS-485 interface must have a unique station address.
3. Choose a **BAUD RATE** from 1200 to 19,200. In general, select the highest value. However, every instrument on the RS-485 interface must be set to the same baud rate.
4. **CRC** indicates the cyclic redundancy checking feature. If the host supports it, activating this option is recommended.
5. When the 545 senses that communications is lost, it can go to a predetermined state (called "shedding"). The **SHED TIME** parameter sets the length of time that communications can be interrupted before the controller sheds. Since the 545 is a stand-alone controller, it does not depend on communications to operate. Therefore, if the "shed" feature is not needed, set it to OFF.
6. **SHED MODE** designates the mode to which the controller goes after it shes. Setting this to MANUAL brings up the following parameters.
7. Use **SHED OUT** to specify an output level if the unit sheds and trips to manual control.
8. To specify a control setpoint (in case the host is supervising the setpoint) if the 545 sheds, set **SHED SP** to DESIG. SP and then, set the parameter **DESIG. SP** to the desired setpoint.

U. CASCADE CONTROL

In Cascade control, the output of one control loop (outside loop) becomes the remote setpoint of a second control loop (inside). The 545 performs this cascade control in a single instrument. The Cascade strategy enables better control of processes with significant lag times by breaking the process into two faster responding loops.

Cascade Control is typically used for the following:

- A slow responding process with a significant lag time
- A process requiring more advanced or tighter control
- A process where two PID control loops need to interact to achieve optimum control. Cascade Control is commonly implemented in temperature control applications where the main control variable is affected by another variable, i.e., pressure (see Figure 7.19).

When the 545 is configured for Cascade, Loop 1 is automatically the primary or outer feedback Loop and Loop 2 is the secondary or inner feedback loop. Loop 1 will not have a physical output, but rather the PID algorithm output is internally fed to Loop 2 as its Setpoint. Loop 2's output comes out of Output 1. Should Loop 2 require two outputs, (e.g. duplex, staged) the second output would come out of Output 2.

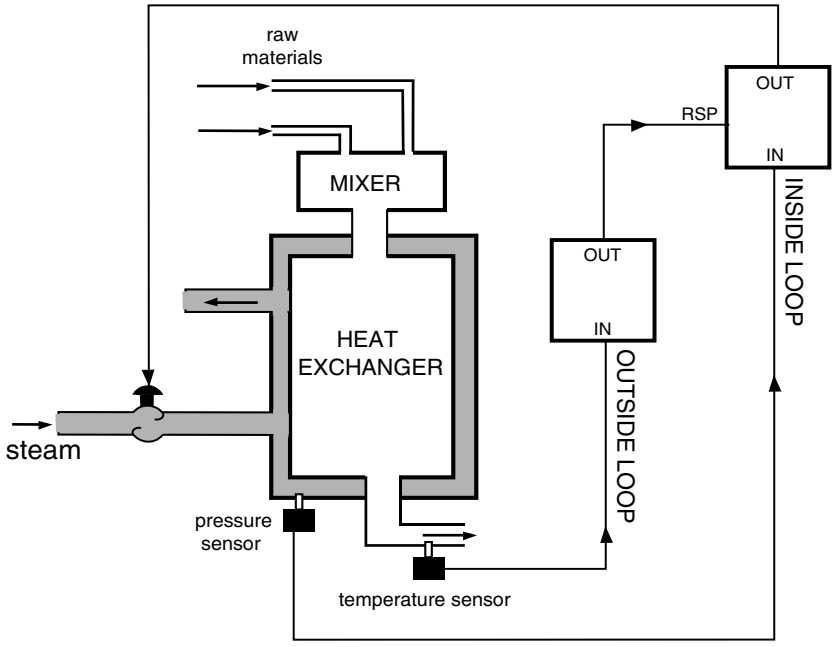


Figure 7.19
Cascade Control of Product Temperature-Functional View

Hardware Configuration

- Wire as in Figure 7.20

Software Configuration

1. For Loop 1
   a. In **CONFIG.** menu, set **CTRL. TYPE** to CASCADE.
   b. In **PV INPUT** menu, set the **PV TYPE.**
   If type is V/mA, set **LO RANGE** and **HI RANGE** parameters to match the transmitter range.

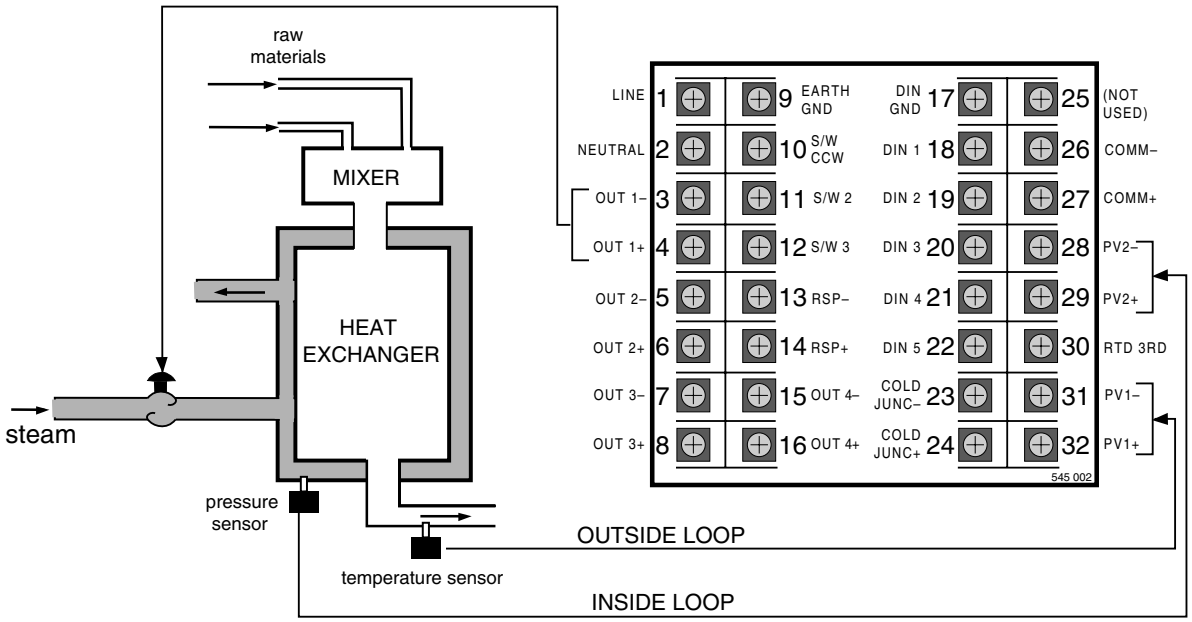


Figure 7.20
Cascade Control of Produce Temperature-Wiring View

c. Go to the **CONTROL** menu.

   If you want an increase in Loop 1 process variable to result in an increase for the Loop 2 setpoint, set **ACTION:1** to DIRECT (acting).

   If you want an increase in Loop 1 process variable to result in a decrease in Loop 2 setpoint, set **ACTION:1** to REVERSE (acting).

d. Use **LOW OUT**. and **HIGH OUT.** to limit the Loop 2 RSP values of without changing the RSP range. Refer to Figure 7.21 for details.

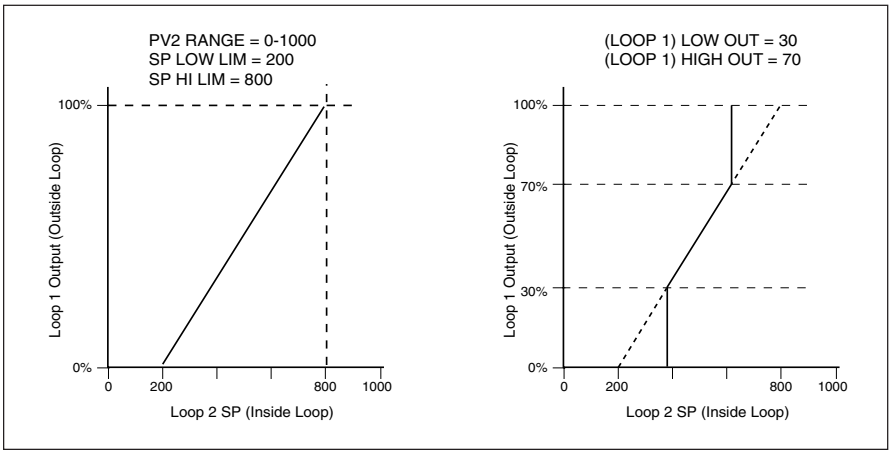


Figure 7.21
The Functions of Cascade Control

2. For Loop 2

   a. In **PV INPUT** menu, set **SP LO LIM**. and **SP HI LIM**. to the portion of range of Loop 2 setpoint over which you want control.

Example

Your Loop 2 range is 0 to 1000; you want its setpoint span to be 100 to 500. Remember that the setpoint span of Loop 2 is driven by the PID output of Loop 1 (the outside loop). Therefore you set SP LO LIM at 200 and SP HI LIM at 800. With these parameters, whenever Loop 1 output is 0%, the Loop 2 SP is 200.

Similarly, whenever Loop 1 output is 100%, then Loop 2 SP is at 800. All the intermediate values follow a linear curve, as shown in Figure 7.21.

Tuning Cascade Control

1. Set the secondary, or inner loop, into Manual, and perform a Pretune on this loop. Once the Pretune is completed, the inner loop must be in Automatic mode.
2. Place the primary, or outer loop, into Manual and perform a Pretune on this loop.
3. Once Pretune is complete, the Cascade Control Loop is completely tuned, and placing the primary loop into Automatic will allow the system to control to the desired Setpoint of the Primary loop. If desired, adaptive tune can be enabled for both loops.

TUNING TIP

1. To pretune Loop 2 with a Type 1 pretune, Loop 1 must be under manual control. Otherwise, the controller will display the error message PRETUNE LP1 AUTO.
2. To pretune Loop 1, Loop 2 must be under Automatic Control. Otherwise the controller will display the error message PRETUNE L2 MANUAL.

V. RATIO CONTROL

Ratio Control is employed in blending applications that require materials to be mixed to a desired ratio. In some applications not only is the ratio being controlled but also the combined flow or total discharge rate of the mixed materials.

Ratio control with one wild stream

Figure 7.22 shows a simple example of a two stream blending application in which one of the streams is wild (uncontrolled). Ratio control for the type of application where one loop is "wild," can be accomplished with a 545 configured for one loop.

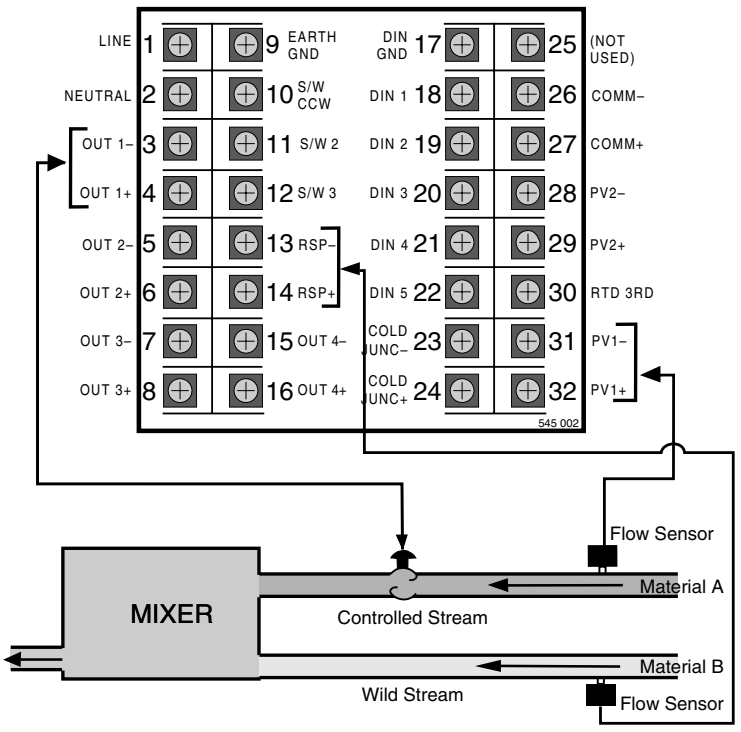


Figure 7.22
Ratio Control in Mixing Application
"Wild Stream"-Wiring View

Hardware Configuration

- Follow wiring as in Figure 7.22.
- Set the PV jumper (of Loop 1) and the RSP jumpers to “mA” position.
  Make sure the software ranges of both inputs match the range of the corresponding transmitter.

Software Configuration

1. In the PV INPUT menu, set HI. RANGE and LOW RANGE
2. In the REM. SETPT. menu, set RSP: LO RNG and RSP:HI RNG .
3. In the TUNING menu, RSP RATIO adjusts the ratio between the two streams. The value of this parameter is multiplied by the remote setpoint signal to yield the effective remote setpoint

Example

In this example, the remote setpoint signal is the flow rate of Material B. The desired amount of B is twice that of A. Therefore, the ratio is 2.0. If the flow of Material B is measured at 50 gallons/minute, the effective remote setpoint value would be 2 times 50, or 100. The 535 would try to maintain the flow of Material A at 100. As the flow of Material B changes, the setpoint would change accordingly, always in a 2:1 ratio.

NOTE:
In dual stream Ratio Control, enter the ratio and bias values in the TUNING menu of Loop 2 under SP RATIO and SP BIAS

Ratio control with combined discharge monitoring

This process requires not only the same ratio of blending as in example 1, but also requires the control of the combined discharge rate. In this example, material A will always by in the proper ratio to material B even as the flow of B is controlled to a specific rate. By controlling the flow rate of B, the total discharge from the mixer (in Figure 7.23) can also be regulated.

Material B (PV1) has the only user defined setpoint in the system. The total flow setpoint of the system is calculated by the following formula:

Total Flow = PV1 + ((PV2 x Loop2 SP Ratio) + SP Bias)

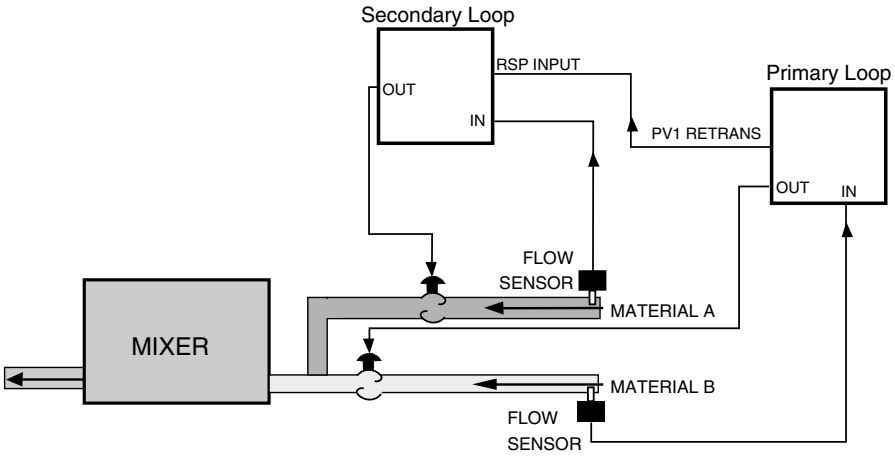


Figure 7.23
Ratio Control in Mixing Application “Controlled Stream”-Functional View

Hardware Configuration

- Follow wiring as in Figure 7.24

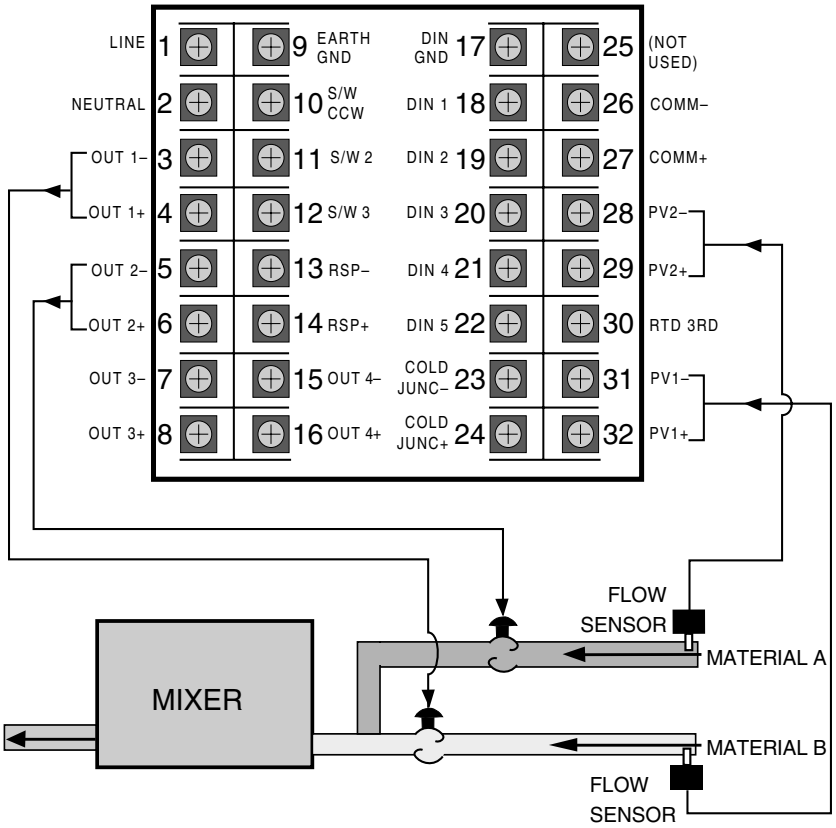


Figure 7.24
Ratio Control in Mixing Application
"Controlled Stream"-Wiring View

TUNING TIP:
Put Loop 1 under manual control when tuning Loop 2, in order to hold Loop 2 SP at a constant.

Software Configuration

1. For Loop 1
   a. In the CONFIG. menu, set CTRL. TYPE to RATIO.
   b. Set all other parameters for a standard control loop.
2. For Loop 2
   a. In the **PV INPUT** menu, set **SP LO LIM.** and **SP HI LIM.** to the same value as those for Loop 1 **LOW OUT** and **HIGH OUT**.
   b. Set all other parameters for a standard control loop.
   c. In the **TUNING** menu (for Loop 2) enter values for **SP RATIO** and **SP BIAS.**

W. FEED FORWARD/FEEDBACK CONTROL

In feedback control, controller output is based on the difference between process variable and setpoint. By contrast, feed forward control generates an output signal based upon the process variable. Feed forward control functions compensate for system lag times by providing a predictive or anticipative output signal based on a process measurement. Typically a feed forward signal is used to enhance the performance of a feedback loop.

Example

Below is an alkaline effluent stream with a constantly changing flow rate, into which an acid is being mixed (Refer to Figures 7.25 and 7.26). The acid valve is positioned as a result of the flow rate of the stream and the pH of the mix. This type of control is called **Feed Forward/Feed Back.** The pH sensor is a closed (feedback) loop that actually measures the result of the valve's action. The flow rate is an open (feed forward) loop, **adding, subtracting or multiplying its output to the pH loop.**

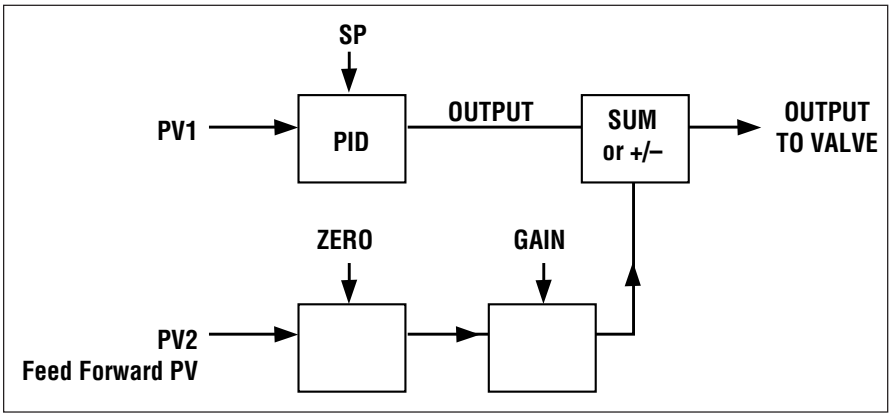


Figure 7.25
Feed Forward Control in Mixing Application-Wiring View

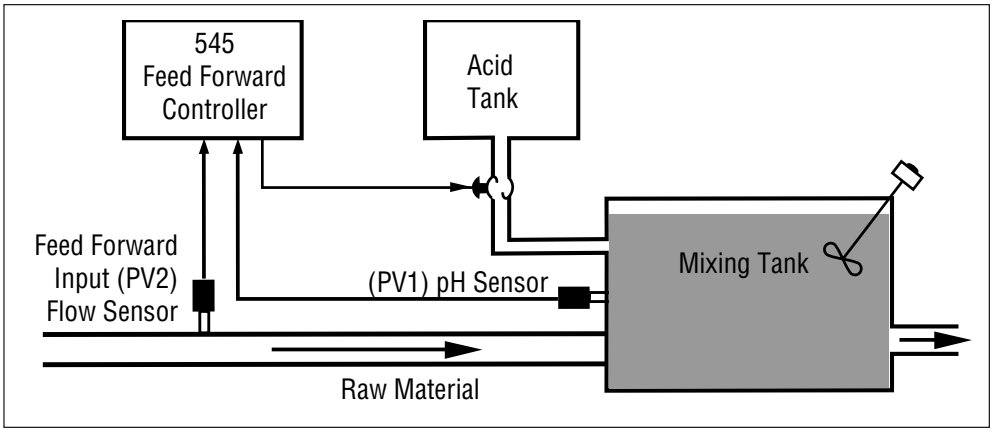


Figure 7.26
Feed Forward Control in Mixing Application-Functional View

Software Configuration

1. In the **CONFIG.** menu , set **CTRL. TYPE** to FFWD. SUM or FFWD. MULT.
2. Set up and tune the PID feedback loop (PV1).
3. In the **TUNING** menu, set the effect of the feed forward input (PV2) on the control output through the following parameters:

a. **FFWD ZERO** (Feed forward zero):
   This parameter is the PV2 (feed forward) value at which there is 0% contribution to controller output. For example, if you want the feed forward contribution to be 0% when PV2 is 500, set this parameter to 500.
b. **FFWD GAIN** (Feed forward gain):
   This parameter is the feed forward output contribution multiplier. For example, a gain of 1 causes a 1% output addition if PV2 is 1 unit above FFWD ZERO. A gain of -2 causes a -2% output addition if PV2 is 1 unit about FFWD ZERO.
c. **FFWD HI LIM.** and **FFWD LO LIM.** (Feed forward high limit & low limit):
   These parameters are output "clamps" used to limit the amount of feed forward contribution to control output. For example, if you wanted the feed forward contribution to never exceed 50%, set **FF HI LIM.** to 50%. **FF LO LIM.** limits the negative contribution to the output. See Figure 7.27 for an illustration of the use of these parameters.

X. LAG TIME

These functions are for slow processes with long or changing lag times.

Figure 7.27 shows a compound loop flow pacing (feed forward/feed back) water chlorination control system. The fixed lag time is the time under steady flow it takes the chlorine to travel from the injector to the residual sampling point. Under fluctuating flow rates, the travel time between the injector and the sampling point will vary. When variable lag time is invoked, changes in the flow past the flow meter automatically increase or decrease the lag time between the injector and sampling point.

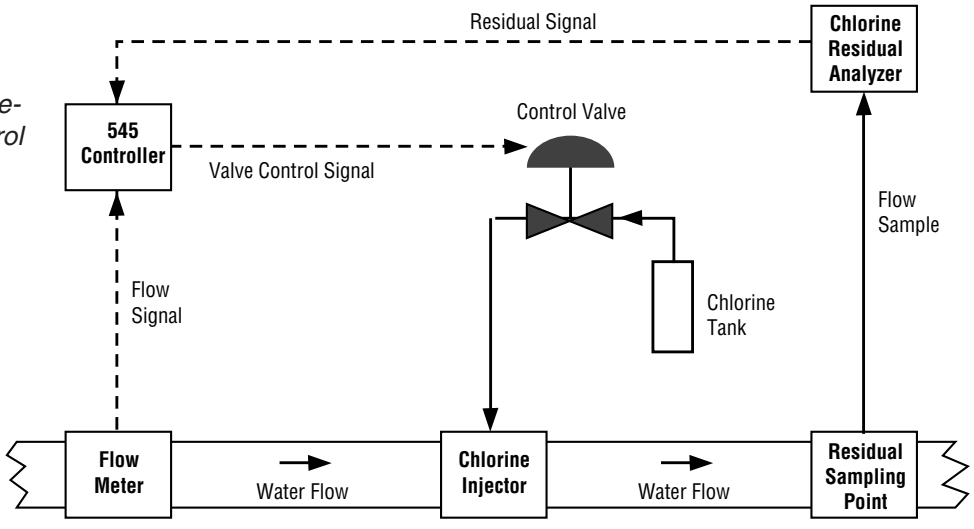


Figure 7.27
Fixed and Variable Lag Example-Compound Loop Chlorine Control

Fixed Lag

Fixed Lag (**FIXED. LAG**) is a constant delay that prevents change in the control output before the results of the previous control value change can be measured. The fixed lag function may be used with the following control types: ONE LOOP, DUAL LOOP, FFWD. SUM and FFWD. MULT.

Software Configuration

1. In the **CONFIG.** menu set **CTRL.TYPE** to : ONE LOOP, DUAL LOOP, FFWD.SUM or FFWD.MULT.
2. In the **CONTROL** menu, set the **FIXED LAG** from 0 to 14400 seconds.
3. Set up all other parameters as needed for your control application.

Remember, changes in the control output will occur only at the end of the **FIXED LAG** period.

Variable Lag

Variable lag (**VARBL. LAG**) can be used in feed forward/feed back control strategies where the feedforward contribution (PV2 input) can vary and thus increase or decrease the amount of actual process lag time. Variable Lag may be used with FFWD. SUM and FFWD. MULT control types.

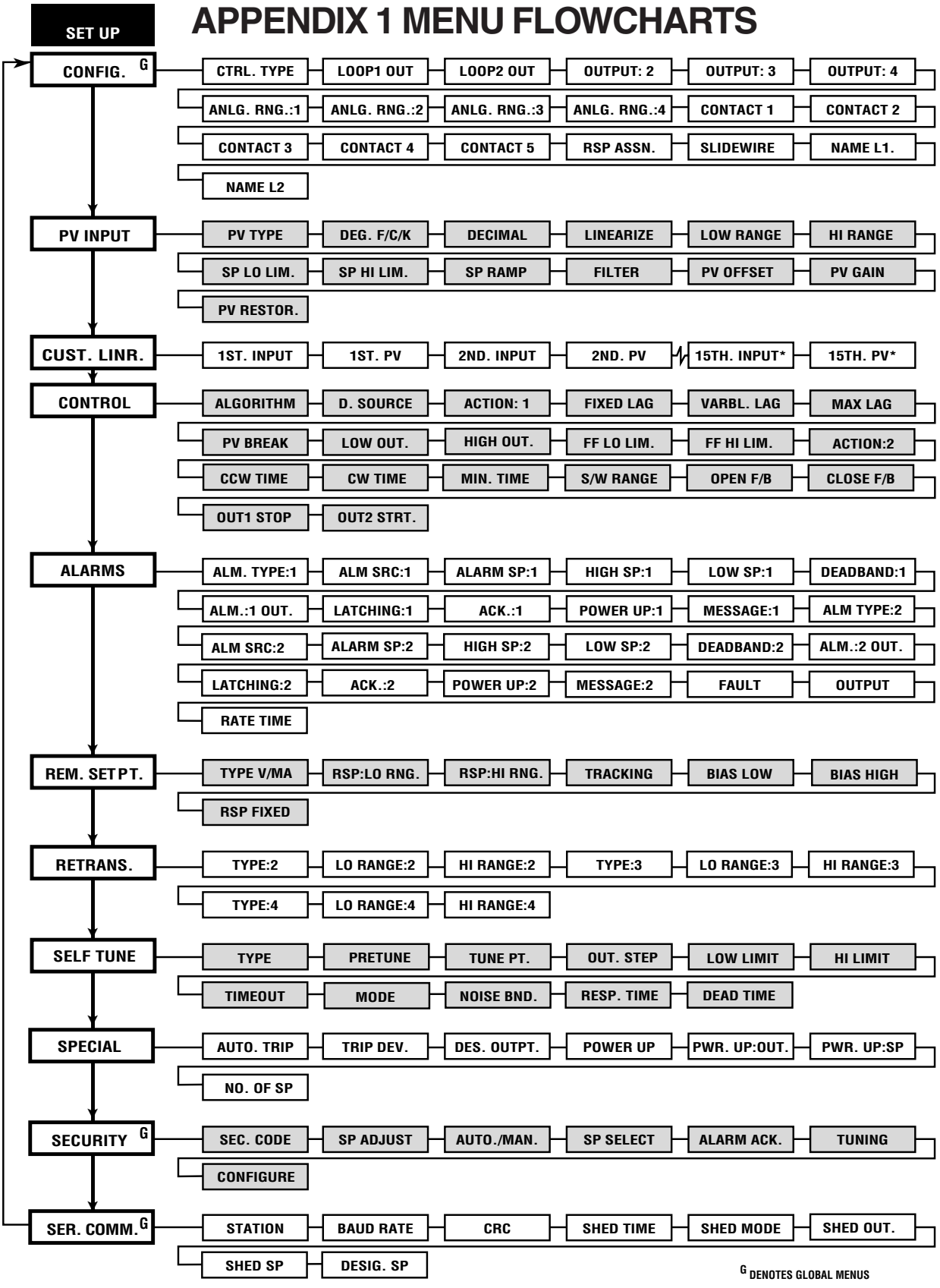
Software Configuration

1. In the **CONFIG.** menu, set **CTRL.TYPE** to **FFWD. SUM** or **FFWD.MULT.**
2. Go to the **CONTROL** menu.
3. Set **FIXED LAG** time (if necessary) from 0 to 14400 seconds.
4. Set the **VARBL. LAG** time from 0 to 14400 seconds. The time set should be in the middle to high end of the variable range of the PV2 input.
5. Set the **MAX. LAG** parameter from 0 to 14400 seconds. This represents the maximum lag time the variable lag feature can achieve.

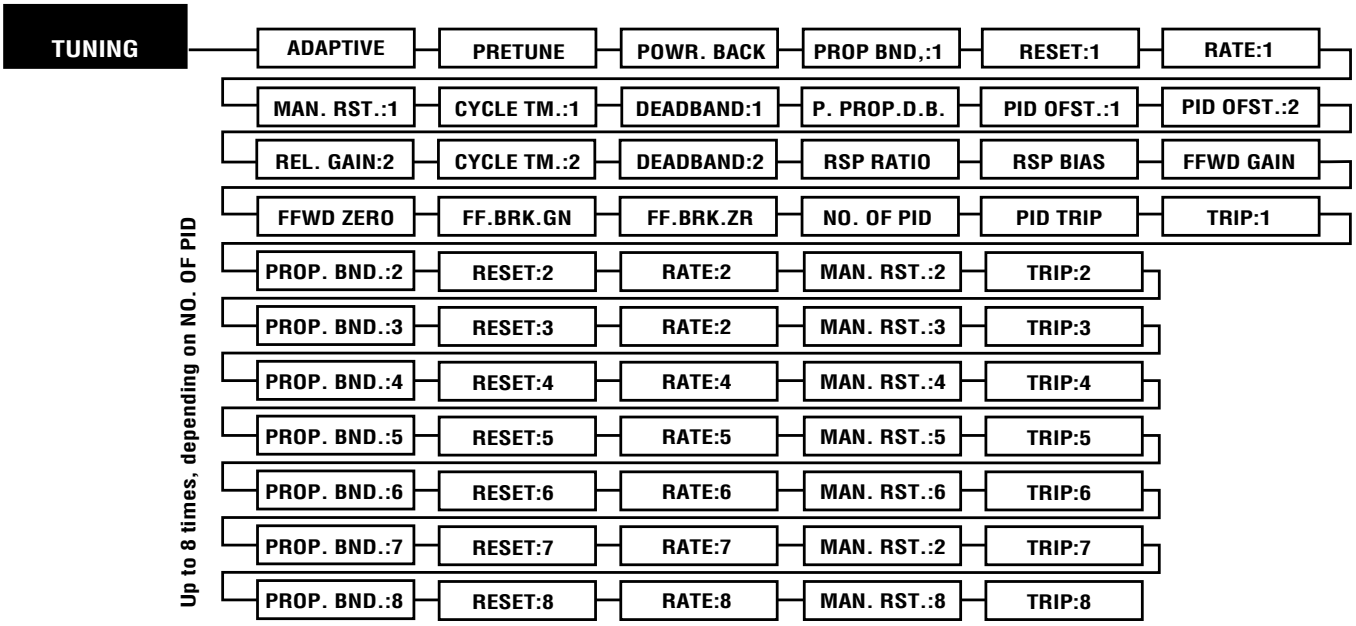
When in the normal operating mode, the lag time will decrease as the PV2 value increases, and will increases as the PV2 value decreases.

Applications

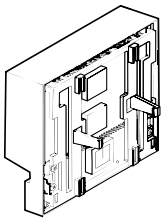
APPENDIX 1 MENU FLOWCHARTS



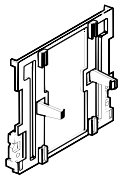
Menu Flowcharts



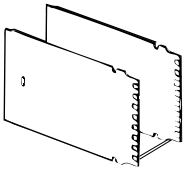
APPENDIX 2
PARTS LIST



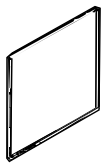
OPERATOR INTERFACE ASSEMBLY shown with bezel insert in place



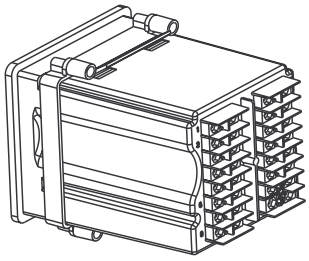
CIRCUIT BOARD SUPPORT (BEZEL INSERT)



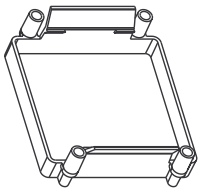
CIRCUIT BOARDS



BEZEL GASKET



CONTROLLER BODY shown with mounting collar in place



MOUNTING COLLAR

ITEM	PART #
Output Modules	
Mechanical Relay Module	535 600
Analog (Milliamp Module)	535 601
Solid State Relay Module	535 602
DC Logic (SSR Drive) Module	535 603
Loop Power Module	535 604
RS-485 Communications Module	535 705
Repair/Replacement Parts	
Operator Interface Assembly	545 634
Power Supply Circuit Board	535 730
Microcontroller Circuit Board	535 731
Option Circuit Board w/no Options	535 720
Option Circuit Board w/Set of 5 Digital Contacts	535 721
Option Circuit Board w/Slidewire Feedback	535 722
Option Circuit Board w/set of 5 Digital Contacts & Slidewire Feedback	535 723
EPROM w/no Remote Setpoint Option	545 740
EPROM w/Remote Setpoint Option	545 741
Lithium Battery	093 128
Jumper Kit: Set of All Jumper Connectors	545 660
Gasket Kit: 1 Panel Gasket & 1 Bezel Gasket	535 662
Mounting Kit: Mounting Collar & 4 screws	535 761
Bezel Retention Screw Kit	535 663
Module Retention Kit for Outputs 1-3 (Includes Retention Plate)	535 664
Module Retention Kit for Output 4: Set of 5 Tie Wraps	535 665
Circuit Board Support (Bezel Insert)	535 075
Engineering unit labels (1 sheet)	535 106

Parts List

APPENDIX 3
TROUBLESHOOTING

SYMPTOM	PROBLEM	SOLUTION
Display will not light up	Defective power source	Check power source and wiring
	Improper wiring	Correct wiring
	Blown in-line fuse	Check wiring, replace fuse
	Unit not inserted in case properly; or, screws have not been tightened.	Remove unit from case (and remove bezel screws), then reinsert unit and properly tighten screws.
Improper/Lost PV reading • Voltage/current	Input jumper selection improperly set	Move jumper to proper location
	Input range improperly selected in software	Select proper range
	Reverse polarity	Check and correct sensor wiring
	If controller powered, improperly wired	Check and correct wiring
	Loop power module not installed	Install module
	Defective transmitter	Replace transmitter
	Transmitter signal out of range	Select proper range in software
Improper/Lost PV reading • Thermocouple	Defective thermocouple	Replace thermocouple
	Input jumper selection improperly set	Select Proper input
	Wrong TC type selected in software	Select proper thermocouple type in software
	Improper wiring	Wire properly
Improper/Lost PV reading • RTD	Defective RTD	Replace RTD
	Input jumper selection improperly set	Move jumper connector to proper location
	Improper wiring	Wire properly
No control output	Output wiring and module location do not match	Check and correct wiring or module location
	If SSR, SSR Drive of Milliamp output, jumpers J1, J2 and J3 are not set properly	Set jumper connector to proper location
	Software configuration does not match hardware	Reconfigure software to match hardware
	PID values not set properly	Set PID values properly
Can't switch to auto control	Input sensor signal is not connected or valid	See LOST PV message
Erratic display	Resetting action due to electrical noise on powerline	Filter power line.
	PID values not set properly	Retune controller

Troubleshooting

Message	When does it occur?	What to do:
DEFAULTS	Whenever the memory is cleared and all parameters revert to factory default settings. This may be done by purposely clearing the memory or when the unit is powered up for the first time or if the software version is changed.	Entering the Set Up mode and changing a parameter will clear the message. If due to something other than the user purposely clearing the memory, call factory for assistance.
LOST CAL. or ERROR: BAD CAL. DATA	Indicates that the calibration data has been lost. Occurs if all the memory has been erased.	Problem should never happen. Must correct the situation and recalibrate. Call factory for assistance.
PV1 UNDER or PV1 OVER or PV2 UNDER or PV2 OVER or	When the process variable value travels slightly outside the boundaries of the instrument span. Does not apply to thermocouple or RTD inputs.	May not need to do anything. May want to check the transmitter accuracy and check to see if range of transmitter matches the range of the controller.
LOST PV1 or LOST PV2	When the controller senses a lost process variable signal or the input signal travels well beyond the instrument span.	Check wiring and sensor/transmitter.
LOST RSP	When the remote setpoint is in use and the controller senses that the signal has been lost or has traveled well outside the range.	Check wiring and remote setpoint source.
COMM SHED	When the communications is lost for longer than the communications shed time.	Check communications wiring, etc. To clear message, must make an auto/manual change.
ERROR: ROM CHECKSUM	On power up, a problem with the EPROM is detected. Controller locks up until fixed.	This is a fatal error and requires an EPROM change. Call factory for assistance.
OUT1 CONF or OUT2 CONF or OUT3 CONF or OUT4 CONF	Upon power up, controller senses that the modules needed for control as determined by software configuration are not present.	Must power down and install correct module combination or reconfigure the controller to match the current module combination.
LOST F/B	The slidewire feedback is sensed as lost.	Check the slidewire wiring.
LOST CJC	The cold junction is sensed as lost.	Call factory for assistance.
ERROR: BAD EEPROM	During power up, an EEPROM failure is detected. Controller locks up until fixed.	This is a fatal error and requires an EPROM change. Call factory for assistance.
NEEDS CAL.	When the controller is powered up with default calibration data (input and output accuracy specifications may not be met).	Enter calibration menu and recalibrate the controller. Call factory for assistance.
ERROR: BAD MODEL NUM.	During power up, a discrepancy was found between the EEPROM's and controller's model numbers. Controller locks up until fixed.	This is a fatal error and requires an EPROM or EEPROM change. Call factory for assistance.

APPENDIX 4
CALIBRATION

- To maintain optimum performance, once a year calibrate the analog input, the cold junction and milliamp output (when used). To achieve published accuracy specifications, follow directions carefully and use calibrated instruments of like quality to those suggested.
- If the controller is moved into an alternate case, or the hardware configuration is changed, and the thermocouple input is needed, recalibrate the cold junction for maximum accuracy. Failure to do so may result in small junction temperature (0.6°C/1.1°F).

Access the parts of the calibration menu as shown in *Figure A4.2*.

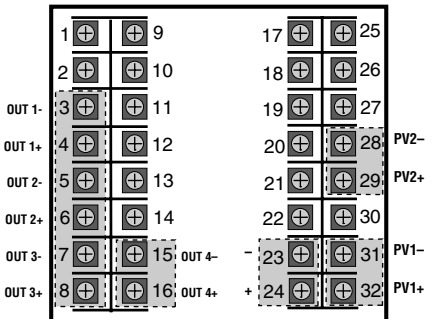


Figure A4.1
545 Rear Terminals for Calibration

Figure A4.2
Flowchart Calibration Menus

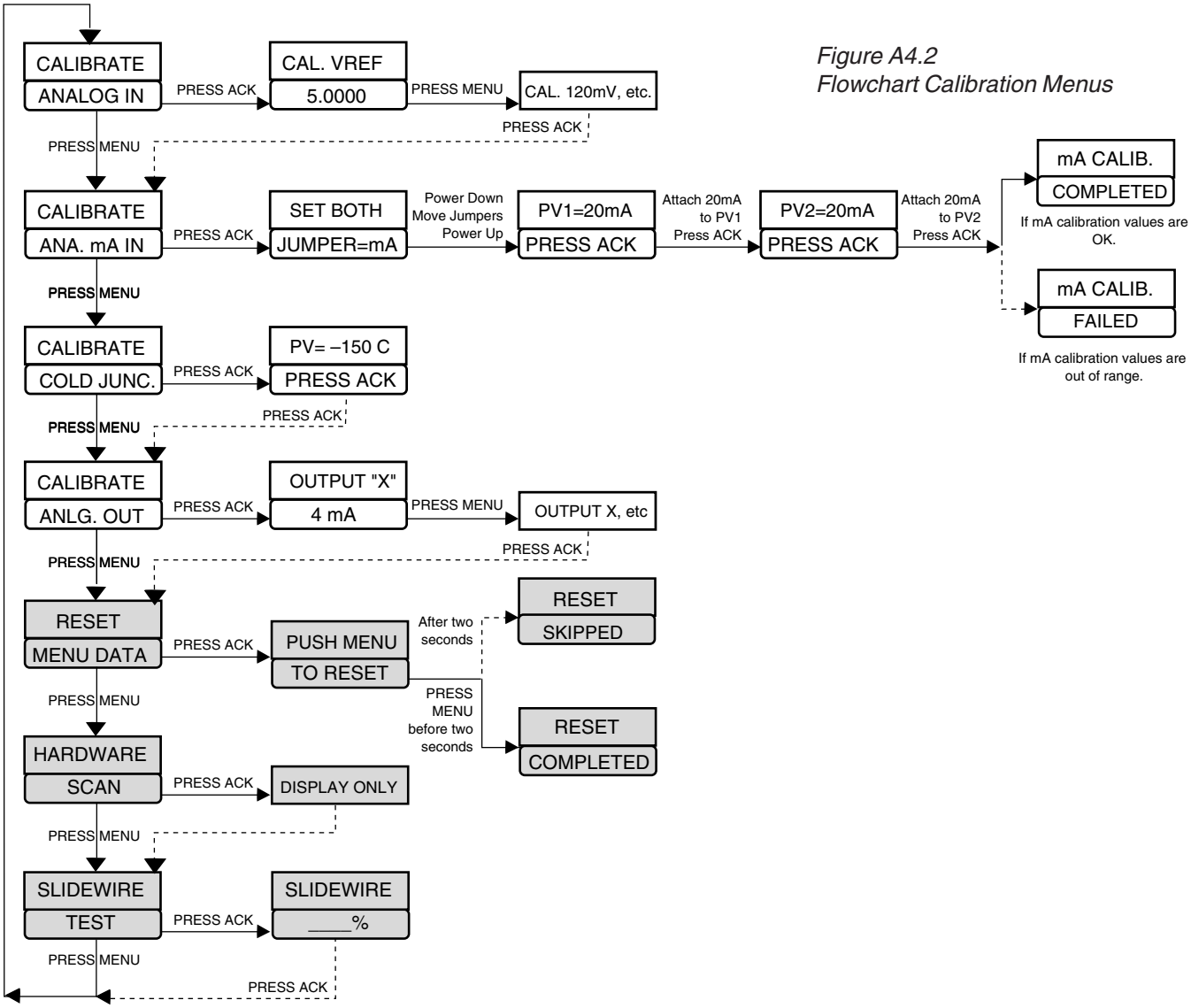
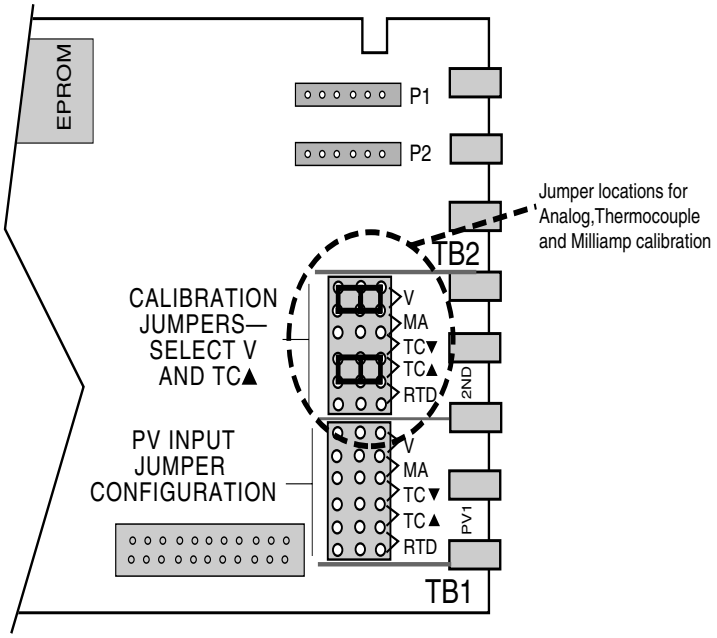


Figure A4.3
Jumper Locations on the Microcontroller Circuit Board



PREPARATION for ALL INPUT CALIBRATIONS

Equipment for analog input calibration:

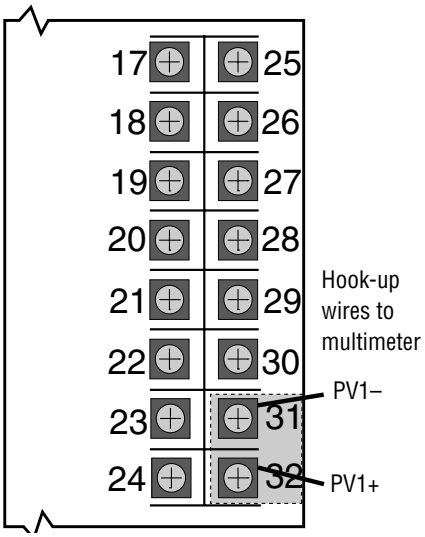
- Precision 5-1/2 or 6-1/2 digit multimeter, e.g., Fluke 8842® or HP3478A® (a 4-1/2 digit meter will sacrifice accuracy)
- Four small pieces of wire
- Test leads with clips
- #2 Phillips screwdriver

Additional equipment for thermocouple input:

- Precision thermocouple calibrator, e.g., Micromite II® by Thermo Electric Instruments
- Special limits grade, Type **T** thermocouple wire

1. Disconnect power to the instrument.
2. Remove chassis from case.
3. On the Microcontroller Circuit Board, locate jumper locations marked **PV1** and 2nd near the edge connector. Reposition both jumper connectors in the 2nd location onto pins for **V** and **TC**s as shown in *Figure A4.3.*
4. Connect hook up wires between terminals 31 and 32 as shown in *Figure A4.4,* and the multimeter.
   Set the meter for **DC volts**.
5. Reinsert chassis into the case and apply power.
   The 2nd and 3rd display should read **CALIBRATE ANALOG IN**.
6. Allow the controller to warm up for at least 30 minutes.
7. Press the **ACK** key to get to the first step/parameter.
   The 2nd display should show **CAL. VREF**; the 3rd display should show a value close to 5.0000.
8. The multimeter should read a value in the range 4.9750 - 5.0250.
   Use the ▲ and ▼ (and **FAST**) keys on the controller until the display on the controller matches the meter reading.

Figure A4.4
Input Calibration Wiring



WARNING!
ELECTRIC SHOCK HAZARD!
Terminals 1 and 2 carry live power. DO NOT touch these terminals when power is on.

9. Press **MENU** key.

   The 2nd display should show CAL. 120mV. The 3rd display should show a value close to 120.000. Match the controller display to the multimeter value using the ▲ and ▼ keys.
10. Press **MENU** three more times. Each time, match the displays of the controller and the multimeter. Press **ACK** when done.

    The 2nd display should show **CALIBRATE**; the 3rd display should show ANA. mA IN.
11. Turn off power to the unit.
12. For **thermocouple input**, proceed to Thermocouple Cold Junction Calibration.
13. For **analog milliamp input**, proceed to Analog Milliamp Input Calibration.
14. For **milliamp output** , let the controller warm up for 10 minutes, then skip to step 5 of Milliamp Output Calibration.
15. If **calibration is complete**, place all the jumpers back in their original positions (as specified in Chapter 3).

THERMOCOUPLE COLD JUNCTION CALIBRATION

1. Connect the two pairs of T/C wire to terminals 28, 29, 31 and 32 as shown in *Figure A4.5.* Make sure the T/C wires are floating (disconnect from the multimeter also), and are not touching each other.
2. Turn on power to the unit and let controller warm up for 30 minutes in the normal horizontal position: while the unit is warming up, the rear face of the controller should be vertical, not horizontal.
3. Press the **MENU** key until the display indicates CALIBRATE COLD JUNC.
4. Press the **ACK** key. The display should show PV = -150 C PRESS ACK.
5. Connect both pairs of T/C wires in parallel—do not daisy chain—to a Type T thermocouple calibrator. (Both pairs must be connected or the calibration will not be accurate.)
6. Set the thermocouple calibrator to an output value of -150° C for a Type T thermocouple and allow the calibrator to stabilize for a few minutes.
7. Press **ACK** to initiate calibration of the cold junction.
8. For **milliamp output calibration**, proceed to Milliamp Output Calibration. Let the controller warm up for 10 minutes, then skip to step 5.
9. If **calibration is complete**, power down, then place all the jumpers in their original positions (as specified in Chapter 3).

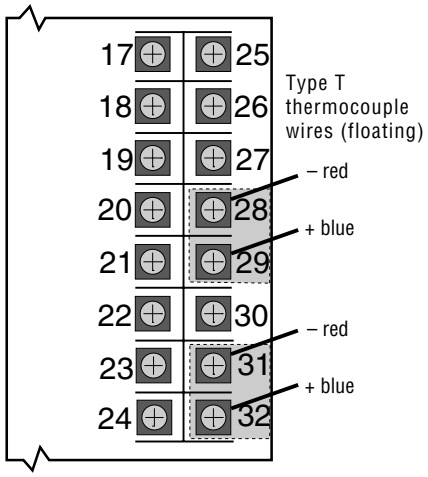


Figure A4.5
Thermocouple/Cold Junction Calibration Wiring

ANALOG MILLIAMP INPUT CALIBRATION

1. Remove the thermocouple wires (if present) from terminals 28, 29, 31 and 32. Replace them with pieces of wire that will be connected to a 20 milliamp input current (see *Figure A4.6*). Make sure terminal screws are securely tightened, but do not connect the wires yet (leave inputs floating).
2. Turn on power to the unit.
3. Press **MENU** until the display indicates CALIBRATE ANA. mA IN, then press **ACK**.

   If the display shows PV1=20mA PRESS ACK, move ahead to step #8.
4. The controller will display **SET BOTH JUMPER**=mA.
5. Power down the controller and remove chassis from the case.

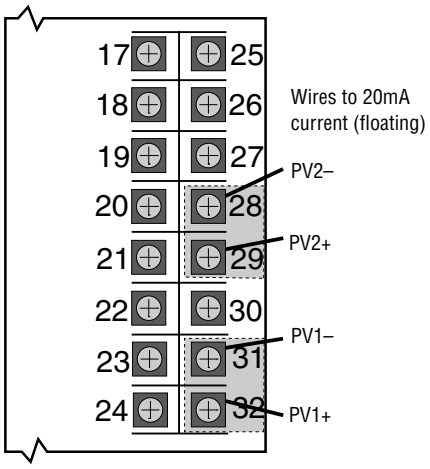


Figure A4.6
Analog mA Input Calibration Wiring

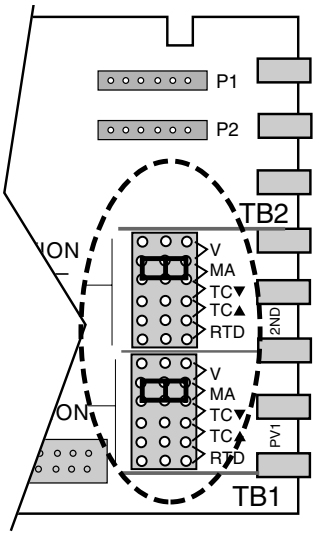


Figure A4.7
Analog mA Input Jumper Positions

6. Remove both input jumper connectors from the pins in the 2nd position. Place one of the jumpers on the PV1 position **mA** pins, and place the other jumper on the 2nd position **mA** pins as shown in *Figure A4.7*.
7. Reinsert the chassis into the case and apply power. The controller should display PV1=20mA PRESS ACK to indicate it is ready to calibrate the PV1 milliamp input.
8. Connect a precision 20mA input to the PV1 terminals (31 is PV1-, 32 is PV1+). Make sure the terminal connections are fastened tightly and that a 20mA current is flowing through PV1. **Do not** connect the 20mA current to PV2 yet.
9. Let the controller warm up for at least 10 minutes (keep in normal horizontal position). Make sure the current is flowing, then press **ACK** to calibrate the PV1 input.
10. If the controller displays PV2=20mA PRESS ACK, PV1 calibration was successful. Move on to step 12.
11. If the controller briefly displays mA CALIB. FAILED, PV1 calibration was not successful.

    Check the 20mA connections, and return to step #3 to recalibrate the PV1 input.
12. Remove the 20mA input from the PV1 terminals, and attach it to the PV2 terminals (see *Figure A4.6)*.

    Make sure the terminal connections are fastened tightly and that a 20mA current is flowing through PV2.
13. Let the controller warm up for an additional 5 minutes (keep in the normal horizontal position). Make sure the current is flowing, then press **ACK** to calibrate the PV2 input.
14. If the controller displays mA CALIB. COMPLETED, PV2 calibration was successful and the analog milliamp calibration procedure has been completed. If calibration is complete, power down. Place the jumpers into their original positions (see Chapter 4).
15. If the controller briefly displays mA CALIB. FAILED, PV2 calibration was not successful. Check the 20mA connections, and return to step #3 to recalibrate the PV1 and PV2 inputs.

MILLIAMP OUTPUT CALIBRATION

If the controller uses milliamp outputs, it is usually not necessary to calibrate them. If the milliamp output are being used for accurate retransmission of data, it is recommended that each output with an analog module be calibrated annually to maintain optimal performance.

Equipment needed:

- Precision 5-1/2 digit multimeter, e.g., Fluke 8842® or HP3478A® (4-1/2 digit meters sacrifice accuracy)
- Two small pieces of wire for every milliamp output
- Test leads with banana clips
- #2 Phillips screwdriver

1. Disconnect power to the instrument.
2. Remove chassis from case.

3. On the Microcontroller Circuit Board locate jumper locations marked PV1 and 2nd near the edge connector. Reposition both jumper connectors in the 2nd location onto pins for V and TCs, as shown in *Figure A4.3.*
4. Reinsert chassis into the case and apply power.
5. Allow controller to warm up for at least 30 minutes.
   The 2nd and 3rd displays should read CALIBRATE ANALOG. IN. (CALIBRATE Menu, ANALOG. IN section).
   Press **MENU** three times to reach the CALIBRATE ANLG. OUT Menu.
6. Connect hook up wires to the terminals for the corresponding milliamp output modules.
   Output 1 uses terminals 3 and 4.
   Output 2 uses terminals 5 and 6
   Output 3 uses terminals 7 and 8 (shown in *Figure A4.8*)
   Output 4 uses terminals 15 and 16.
   Attach the test leads from the multimeter to the wires, and then plug the test leads into the meter. Set the meter for DC milliamp.
7. Press **ACK**. The 2nd display will read OUTPUT1, OUTPUT2, OUTPUT3 or OUTPUT4 (depending on the module installation).
8. Press **MENU** to scroll to the output to be calibrated (see *Figure A4.9)*. The 3rd display should read 4mA.
   The multimeter should read a value close to 4.00.
9. Wait one minute. Use ▲ and ▼ (and **FAST**) on the controller to change the meter's display to exactly 4.00mA.
10. Press **MENU**. The 3rd display should read 20mA.
11. Let this setting stabilize for 5 minutes. Use ▲ and ▼ (and FAST) on the controller to change the meters display to exactly 20mA.
12. **To calibrate another analog output**:
    Move the wires and test leads to the new output terminals.
    Press **MENU** until the 3rd display shows 4mA for the corresponding output in the 2nd display. Repeat step 9-11.
13. To complete calibration, press **ACK** key, disconnect the power and place the jumper connectors back into their original position.

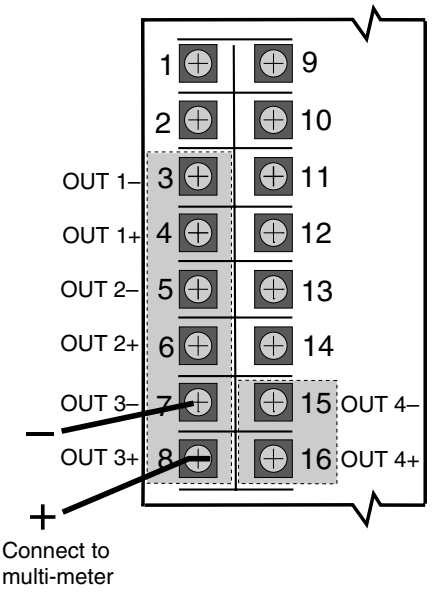


Figure A4.8
Milliamp Output Calibration Wiring

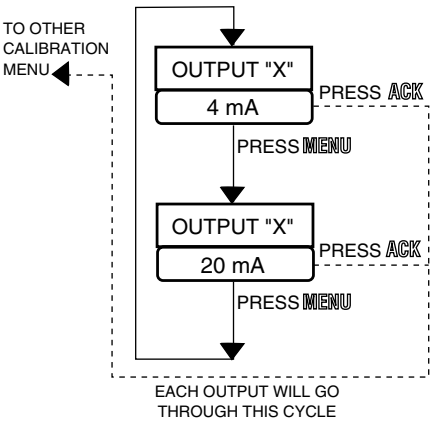


Figure A4.9
Output Module Menu Cycle

RESET MENU DATA

Resets all parameter values back to their factory default values (except for calibration information). Refer to the flowchart in *Figure A4.2.*

1. Disconnect power to the instrument.
2. Remove chassis from case.
3. On the Microcontroller Circuit Board, set jumpers at the 2nd PV location to **V** and **TC▲**.
4. Press **MENU** key until the display shows RESET MENU DATA.
5. Press the **ACK** key.
6. Press **MENU** key within two seconds to reset the menu data.
   If successful, RESET COMPLETED will appear in the display.
   If failed, RESET SKIPPED will appear instead.
7. To try again, press **ACK** key, and then press **MENU** key within 2 seconds.
8. When complete, return jumpers to their original positions.

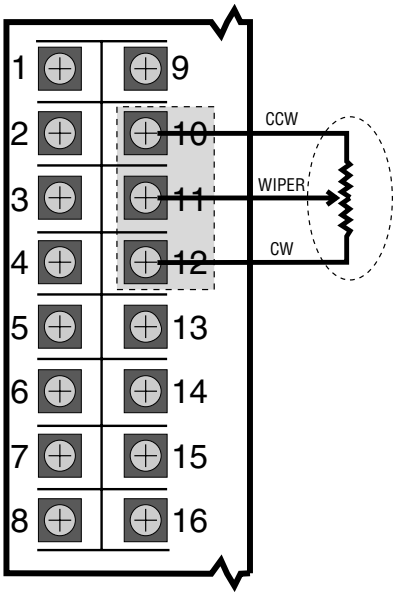


Figure A4.10
Slidewire Test Wiring

HARDWARE SCAN

Use this read-only feature to identify the output hardware and installed options of the controller.

1. Set the jumpers to **V** and **TC▲** (see Figure *A4.3*).
2. Power up the controller
3. Press **MENU** until HARDWARE SCAN is displayed.
4. Press **ACK** to initiate the hardware display.
5. When complete, return jumpers to their original positions.

SLIDEWIRE TEST

If the slidewire option is installed, use the following to test its function:

1. Press **MENU** to scroll to the **SLIDEWIRE TEST** menu (refer to *Figure A4.2*)
2. Attach a 100 ohms to 1000 ohms potentiometer to terminals 10, 11 and 12 as shown in *Figure A4.10.*
3. Moving the potentiometer from one end to the other should display from "0%" to "100%" on the controller.
4. If the error message OPEN appears, check the connectors and try again.
6. Press **ACK** to exit.

QUICK CALIBRATION PROCEDURE

This procedure may benefit users that have ISO or other standards requiring periodic calibration verification. It enables verification and modification of the PV input without entering the "Factory Configuration" mode.

1. Power down the 545 controller and place the input jumpers in the desired position (see Figure A4.3 and Figure A4.7).
2. Replace the process variable (PV1 or PV2) input signal with a suitable milliamp calibration device.
3. Apply power and allow controller to warm up for 30 minutes.
4. Place controller in **MANUAL** mode then press **FAST + MENU** to reach the **PV INPUT** menu.
5. Press **MENU** until the **OFFSET** parameter appears in the 2nd display.
6. Adjust the calibration device to an output signal equal to the 0% range value for the particular input sensor (for example, 4mA for a 4-20mA input).
7. Verify value indicated in the 1st display is equal to the 0% range value for the particular input sensor. If incorrect, use the ▲ and ▼ keys to scroll to the correct value.
8. For linear voltage or mA input: Press **MENU** until the **PV GAIN** parameter appears in the 2nd display.

   For thermocouple or RTD input: Continue to step #9.
9. Adjust the calibration device to an output signal equal to the 100% range value for the particular sensor.
10. Verify that the value shown in the 1st display is equal to 100% of the range value for the particular input sensor. If the value is not correct, use the ▲ and ▼ keys to scroll to the correct value.
11. Repeat steps 4 through 10 to verify all values.
12. Press **DISPLAY** to return to the **OPERATION** mode.

APPENDIX 5
SPECIFICATIONS

ACCURACY

		TYPICAL	MAXIMUM
LINEAR	(Voltage)	± 0.025% of full scale	± 0.100% of full scale
	(Current)	± 0.050% of full scale	± 0.150% of full scale
RTD	1°	± 0.050% of span	± 0.150% of span
	0.1°	± 0.095% of span	± 0.225% of span
THERMOCOUPLE			
J, K, N, E (> 0°C)		± 0.060% of span	± 0.150% of span
J, K, N, E (< 0°C)		± 0.150% of span	± 0.375% of span
T (> 0°C)		± 0.100% of span	± 0.250% of span
T (< 0°C)		± 0.250% of span	± 0.625% of span
R, S (> 500°C)		± 0.150% of span	± 0.375% of span
R, S (< 500°C)		± 0.375% of span	± 0.925% of span
B (>500°C)		± 0.150% of span	± 0.375% of span
B (<500°C)		± 0.500% of span	± 1.000% of span
W, W5 & Platinel II		± 0.125% of span	± 0.325% of span

Accuracy specifications are at reference conditions (25°C—Still Air) and only apply for NIST ranges. PV1 Thermocouple Cold Junction accuracy is 0.02°/degree from reference conditions. PV2 Thermocouple Cold Junction Accuracy is 0.10°/degree from reference conditions. Display accuracy is ± 1 digit. Cold Junction accuracy is 0.02°/degree. Detailed accuracy information is available upon request.

CONTROL ALGORITHM

PID, P with manual reset, PI, PD with manual reset, and On-Off are selectable from the front panel. Duplex outputs each use the same algorithm, except On-Off may be used with PID. The control output may be configured for cascade, ratio and feed forward applications.

Fixed lag capability is available for PID loops with a constant delay.

Variable lag capability is available when using the feed forward mode where the source of feed forward contribution may fluctuate. Feed forward contribution automatically modifies the length of the lag time.

TUNING PARAMETERS

Proportional Band: 0.1 to 999% of input range

Integral: 1 to 39999seconds/repeat

Derivative: 0 to 600 seconds

Manual Reset/Load Line: 0 to 100% output

Cycle Time: 0.3 to 120 seconds

On-Off Deadband: up to 15% of input range (in eng. units)

Up to eight sets of PID values may be stored in memory and selected automatically, based on setpoint value, process variable value, or the corresponding local setpoint (SP1–SP8).

SELF TUNING OF PID VALUES—AVAILABLE FOR EACH LOOP

POWERTUNE® On–demand "pretune": This is an open loop algorithm that may be used on its own to calculate PID variables, or it can be used to provide preliminary PID values, as well as process identification information to be used by the adaptive tune.

Three pretune types are available: TYPE 1 for slow thermal processes; TYPE 2 for fast fluid or pressure applicaitons; and TYPE 3 for level control applications.

Adaptive tune: Our exclusive POWERTUNE® adaptive tuning algorithm automatically adjusts the PID values whenever a process upset occurs. Preliminary information may be entered manually or automatically calculated by our pretune algorithm.

OVERSHOOT PROTECTION

POWERBACK is proprietary, user-invoked, setpoint overshoot protection algorithm. When invoked, POWERBACK reduces or eliminates setpoint overshoot at power up or after setpoint changes. POWERBACK monitors the process variable to make predictive adjustments to the control parameters, a feature that helps eliminate overshoot of setpoint.

ISOLATION

Inputs and outputs are grouped into the following blocks:

Block 1A: process variable input 1
Block 1B: process variable input 2
Block 2: outputs 1, 2, and 4
Block 3: communications, set of five digital inputs, output 3 (Earth Ground)
Block 4: remote setpoint

Each block is electrically isolated from the other blocks to withstand a HIPOT potential of 500 Vac for 1 minute or 600 Vac for 1 second, with the exception of blocks 1 and 4, which are isolated to withstand a HIPOT potential of 50 volts peak for 1 minute between each other. Inputs and outputs are not isolated from other inputs and outputs within the same block. Blocks 1A & 1B are ground loop isolated from each other to 10V peak to peak.

CONTROLLER ARCHITECTURE

The 545 Controller hardware can be configured as follows:

Inputs: Two universal process variable inputs are standard. Available options include 1 remote setpoint, 1 slidewire feedback and 5 digital inputs.

Outputs: 4 outputs are available. See Ordering Information.

RS-485 Communications: Available as an option with any configuration.

PROCESS VARIABLE INPUTS—2 AVAILABLE

Universal input type. Any input type may be selected in the field. Selection of input type (thermocouple, RTD, voltage or current) via jumper. Selection of particular sensor or range is via front panel.

(continued on next page)

Specifications

THERMOCOUPLES	RANGE °F	RANGE °C
B	104 to 3301	40 to 1816
E	–454 to 1832	–270 to 1000
J	–346 to 1832	–210 to 1000
K	–418 to 2500	–250 to 1371
N	–328 to 2372	–200 to 1300
R	32 to 3182	0 to 1750
S	32 to 3182	0 to 1750
T	–328 to 752	–200 to 400
W	32 to 4172	0 to 2300
W5	32 to 4172	0 to 2300
Platinel II	–148 to 2550	–100 to 1399

RTDS	RANGE °F	RANGE °C
100 ohms Pt. (DIN)	–328 to 1562	–200 to 850
	–328.0 to 545.0	–200.0 to 285.0
100 ohms Pt. (JIS)	–328 to 1202	–200 to 650
	–328.0 to 545.0	–200.0 to 285.0
100 ohms Pt. (SAMA)	–328 to 1202	–200 to 650
	–328.0 to 545.0	–200.0 to 285.0

TRANSMITTER SIGNALS	INPUT RANGE
Milliamps DC	4 to 20
	0 to 20
Voltage DC	1 to 5
	0 to 5
Millivolts DC	0 to 10
	0 to 30
	0 to 60
	0 to 100
	–25 to 25

LINEARIZATION

Thermocouple and RTD inputs are automatically linearized.
Transmitter inputs may be linearized with a square root function or user-defineable
15-point straight line linearization function.

INPUT IMPEDANCE

Current Input: 250 ohms Thermocouples: 10 Mohms

Voltage Input: 1 Mohms RTDs: 10 Mohms

UPDATE RATE

Input is sampled and output updated 8 times per second. Display is updated five times per second.

TRANSMITTER LOOP POWER

Isolated 24 Vdc (nominally loaded) loop power supply is available if a loop power module is installed in an output socket. Capacity is 25 mA.

INPUT SIGNAL FAILURE PROTECTION

When input is lost, output is commanded to a predetermined output (-5 to 105%). Thermocouple burnout is selectable for upscale or downscale.

INPUT FILTER

Single pole lowpass digital filter with selectable time constant from 0 to 120 seconds.

CALIBRATION

The controller comes fully calibrated from the factory and continuously calibrates itself for component aging due to temperature and time, except for the reference voltage. Field calibration can be easily performed with a precision multimeter and thermocouple simulator. Process variable offset and gain factors are provided to correct for sensor errors.

OUTPUT MODULES

The controller can have a total of four control outputs, alarm outputs and/or loop power modules installed. There are five types of output modules which can be configured to suit your particular application. The modules may be ordered factory-installed, or they may be installed in the field.

Analog module: Either 0–20mA or 4–20mA (front panel selectable) into a load up to 1000 ohms. Accuracy ± 5µA @ 25°C.

Mechanical relay module: SPDT electromechanical relay. Resistive load rated at 5 amps at 120/240 VAC. Normally open or normally closed selection is made by jumper. Output 4 is rated at 0.5 amps at 24 VAC and is always normally open.

Solid state relay (triac) module: Resistive load rated at 1 amp at 120/240 VAC. Output 4 is rated at 0.5 amps at 24 VAC. These outputs are normally open.

DC logic (SSR drive) module: "ON" voltage is 17 Vdc (nominal). "OFF" voltage is less than 0.5 Vdc. (Current limited to 40mA.)

Loop power supply module: Current is limited to 25mA @ 24V (nominally loading).

CONTROL OUTPUTS

Up to two output modules per loop may be designated for control. Any combination of output modules, with the exception of the loop power supply module, may be used.

Duplex control is available if output modules are installed in the first and second output sockets for either loop.

Position proportioning control with feedback is available if mechanical or solid state relay modules are installed in the first two output sockets, and the slidewire feedback option is installed. The feedback option may be added in the field. Slidewire feedback range is 0 to 1050 ohms (Slidewire SP available for either loop 1 or loop 2—one loop only).

"Velocity" position proportioning control is available by installing mechanical or solid state relay modules in the first two output sockets. A special algorithm controls an electric actuator without the slidewire feedback signal.

Staged (split range) outputs are available if analog modules are installed in the first and second output sockets. This algorithm will allow the output range to be split between the two outputs.

RETRANSMISSION OUTPUT

Based on available outputs (any socket not used for control), up to two different variables can be simultaneously programmed for retransmission. Each precise, 16-bit resolution output may be scaled for any range. Variable selection includes: PV1, SP1, RAMP SP1, LOOP1OUT, PV2, SP2, RAMP SP2 and LOOP2OUT.

ALARMS

The 545 controller has two software alarms per loop for a total of four alarms. High and low alarms may be sourced to the PV, SP, RAMP SP, DEVIATION and OUTPUT. If an alarm is tripped, the alarm message will show, the ACK key will illuminate (if acknowledgeable) and the ALM icon will light. If the alarm is tied to the first available non-control output, the "1" below the ALM icon will light. Similarly, if the alarm is tied to the second non-control output, the "2" below the ALM will light. The availability of outputs determines how many alarms can be tied to relays.

Global Alarm feature allows one or more of the internal software alarms to be tied to the same single, physical output. The acknowledge key is active for alarms associated with either loop. The order in which alarms are acknowledged is: loop1 alarm1, loop1 alarm 2, loop2 alarm 1, loop2 alarm2.

DIGITAL INPUTS

A set of five external digital inputs activated by dry contacts (or open collector transistors) are available. Each can be configured to perform one of the following functions:

- Select remote setpoint
- Select manual control
- Select second local setpoint
- Select a second set of PID values
- Acknowledge alarms
- Simulate front panel keys
- Select either direct or reverse control action
- Disable adaptive tuning
- Addressable through serial communications only
- Inhibit the reset term
- Lock controller in manual mode

In addition, if the set of five digital inputs is installed, two can be designated to select one of four local setpoints per loop (and associated PID set, if desired) via a binary coded decimal (BCD) input.

SETPOINT SELECTION

A remote setpoint input is available for one of the two loops. Signal is 0–20/4–20 mADC or 0–5/1–5 VDC (jumper selectable). Signal may be rationed and biased. **Eight local setpoints per loop** may be stored in memory. Setpoint selection is made via SET PT key or digital contact(s).

FAULT OUTPUT

One of the alarm outputs may be designated to also energize if the input signal is lost.

SERIAL COMMUNICATIONS

Isolated serial communications is available using an RS-485 interface. Baud rates of up to 19,200 are selectable. The protocol supports CRC data checking. If communications is lost, a time-out feature will command the controller to a particular control mode and specific setpoint or output if desired. Outputs 2–4 and digital inputs can act as "host-controlled" I/O independent of the controller's function. May be installed in the field.

DIGITAL DISPLAYS

Upper display: five-digit, seven-segment. Used exclusively for displaying the process variable value. Height is 15 mm (0.6 in.).

2nd display: nine-character, 14-segment alphanumeric. Used for displaying setpoint, deviation, output value, slidewire position (actual valve position) and configuration information. Height is 6 mm (0.25 in.).

3rd display: nine-character, 14-segment alphanumeric. Used for indicating which loop is displayed and for displaying alarm messages and configuration information. Height is 6 mm (0.25 in.). All displays are vacuum fluorescent. Color is blue-green.

STATUS INDICATORS

There are two types of indicators: icons and illuminated keys.

ALM 1 and ALM 2 icons: alarm 1 and alarm 2 status.

OUT 1 and OUT 2 icons: control output 1 and control output 2 status.

PV2 icon illuminated: 2nd loop is on display.

DISPLAY key illuminated: 2nd loop is on display.

MAN key illuminated: controller is in manual control mode.

ACK key illuminated: alarm may be acknowledged.

SET PT key illuminated: setpoint other than primary local setpoint is active.

MENU key illuminated: controller is in configuration mode.

DIMENSIONS

Meets 1/4 DIN designation as specified in DIN standard number 43 700. See diagram for details.

MOUNTING

Panel-mounted. See diagram for details.

WIRING CONNECTIONS

31 screw terminals in the rear of the instrument.

(continued on next page)

Specifications

POWER CONSUMPTION

15 VA at 120 VAC, 60 Hz (typical).

WEIGHT

Approximately 1 kg (2.2 lbs.).

AMBIENT TEMPERATURE

Operative Limits: 0 to 50°C (32 to 122°F).

Storage Limits: –40 to 70°C (–40 to 158°F).

RELATIVE HUMIDITY

10 to 90%, non-condensing.

VOLTAGE AND FREQUENCY

Universal power supply: 90 to 250 VAC, 48 to 62 Hz.

NOISE IMMUNITY

Common mode rejection (process input): >120 dB.

Normal mode rejection (process input): >80 dB.

AC line is double filtered and transient protected. Snubbers are provided for each relay output.

CONSTRUCTION

Case: extruded, non–perforated black anodized aluminum with ABS plastic sleeve.

Bezel: black plastic ABS.

Chassis assembly: plug-in type.

Keys: silicone rubber with diffusion printed graphics.

NEMA rating: front panel conforms to NEMA 4X when instrument is properly installed.

AGENCY APPROVALS

LR 84603 LISTED Process Control Equipment 4N66 (Heavy Industrial)

(Available as an option)

MEMORY RETENTION

Lithium battery maintains all programming for approximately ten years.

SECURITY

There are two levels of access: restricted and full. A configurable code is used to enter the full access level. Functions not available in the restricted level are configurable.

APPENDIX 6
GLOSSARY

adaptive control: Control in which automatic means are used to change the type or influence (or both) of control parameters in such a way as to improve the performance of the control system.

adaptive tune: A component of the 545 self tune function which continuously monitors the process and natural disturbances and makes adjustments in the tuning parameters to compensate or improve the performance of the control system.

alarm: A condition, generated by a controller, indicating that the process has exceeded or fallen below the set or limit point.

alarm, band: A type of alarm set up where a band is created around the control setpoint.

alarm, deviation: An alarm similar to a band alarm except it only creates a band on one side of the alarm setpoint.

alarm, fault: An indication that becomes active upon loss of process variable. Fault alarm operates in addition to other alarm assignments.

alarm, global : The single physical output to which one or more internal software alarms are tied.

alarm, high process variable: A type of alarm that is set up to occur when the process variable goes above the alarm setpoint.

alarm, low process variable: A type of alarm that is set up to occur when the process variable goes below the alarm setpoint.

alarm, manual: A type of alarm set up to occur when the controller is put into manual mode of operation.

alarm, power up: A type of alarm that determines alarm condition on power up of the controller.

alarm, rate-of-change: A type of alarm set up to occur when there is an excessive change in the process variable (PV) value.

automatic controller: A device or combination of devices which measures the value of a variable, quantity, or condition and operates to correct or limit its deviation from the setpoint.

baud rate: Any of the standard transmission rates for sending or receiving binary coded data.

bias: A reference level. A numeric value in a digital system or a voltage or current in an analog system.

binary coded decimal (BCD): A notation in which the individual decimal digits are represented by a group of binary bits, e.g., in the 8-4-2-1 coded decimal notation each decimal digit is represented by four binary bits.

bezel: The flat portion surrounding the face of the controller, which holds the keys and display.

bump: A sudden increase in the output power initiated by the controller in order to determine the system response during a self tune procedure.

calibration: The act of adjustment or verification of the controller unit by comparison of the unit's reading and standards of known accuracy and stability.

cascade control: Control in which the output of one (controller or) loop is the setpoint for another (controller or) loop.

closed loop: Control system that has a sensing device for process variable feedback.

cold junction: Point of connection between thermocouple metals and the electronic instrument.

cold junction compensation: Electronic means used to compensate for the effect of temperature at the cold junction.

configuration: Also called Set Up. The selection of hardware devices and software routines that function together.

contact: In hardware, a set of conductors that can be brought into contact by electromechanical action and thereby produce switching. In software, a symbolic set of points whose open or closed condition depends on the logic status assigned to them by internal or external conditions.

control action: The slope of the output of the instrument in reference to the input, e.g., direct output increases on rise of input. Typical cooling response or reverse output decreases on rise of input (typical heating response).

control action, derivative (rate) (D): The part of the control algorithm that reacts to rate of change of the process variable.

control action, integral (reset) (I): The part of the control algorithm that reacts to offset between setpoint and process variable.

control action, proportional (P): Control action in which there is a continuous linear relation between the output and the input.

control action, proportional plus derivative (PD): A control algorithm that provides proportional control with the addition of derivative action to compensate for rapid changes in process variable.

control action, proportional plus integral (PI): A control algorithm that provides proportional control with the addition of integral action to compensate for offsets between setpoint and process variable.

control action, proportional plus integral plus derivative (PID): A control algorithm that provides proportional control with both integral and derivative action.

control, adaptive: (see adaptive control)

Glossary

control algorithm: A mathematical representation of the control action to be performed.

control, cascade: (see cascade control)

control output: The end product which is at some desired value that is the result of having been processed or manipulated.

control mode, automatic: A user selected method of operation where the controller determines the control output.

control mode, manual: A user selected method of operation where the operator determines the control output.

control parameters: User defined values that specify how the process is to be controlled.

controlled variable: A process variable which is to be controlled at some desired value by means of manipulating another process variable.

CRC (cyclic redundancy check): An error checking technique in which a checking number is generated by taking the remainder after dividing all the bits in a block (in serial form) by a predetermined binary number.

CSA: Acronym for Canadian Standards Association.

cycle time: The time necessary to complete a full ON-through-OFF period in a time proportioning control system.

cycling (oscillation): A periodic change in the factor under control usually resulting in signal excursions above and below the control point.

DIN: Deutsche Industrial Norms, a German agency that sets standard for engineering units and dimensions.

damping: The decrease in amplitude of an oscillation due to the dissipation of energy.

damped, 1/4 amplitude: The loss of one-quarter of the amount of amplitude with every oscillation.

dead band: A temperature band between heating and cooling functions; the range through which an input can be varied without initiating observable change in output.

dead time: The interval of time between initiation of an input change or stimulus and the start of the resulting observable response.

default settings: Parameters selections that have been made at the factory.

derivative: Anticipatory action that senses the rate of change of temperature, and compensates to minimize overshoot and undershoot. Also “rate.”

derivative action: (See control action, derivative)

deviation: The difference between the value of the controlled variable and the value at which it is being controlled.

digital input: Used in this manual to indicate the status of a dry contact; also called “gate”.

display, 1st: The top, largest display of controller face that is used to display the process variable value.

display, 2nd: The middle display of the controller face used to indicate: Operation Mode — setpoint, deviation or output.; Tuning and Set Up Mode — parameter or parameter menu.

display, 3rd: The bottom display of the controller face that is used to indicate: Operation Mode — alarm or error message; Tuning of Set up Mode — the value or choice of the parameter.

disturbance: An undesired change that takes place in a process that tends to affect adversely the value of a controlled variable.

duplex control: Control method where the temperature of the end product is maintained by controlling two final elements using two of the 545 outputs.

duty cycle: Percentage of “load ON time” relative to total cycle time.

earth ground: A terminal used on the 545 to ensure, by means of a special connection, the grounding (earthing) of part of the controller.

engineering unit: Terms of data measurement such as degrees Celsius, pounds, grams, etc.

error: The difference between the actual and the true value, often expressed as a percentage of either span or full scale.

feedback: Process signal used in control as a measure of response to control action; the part of a closed-loop system which automatically brings back information about the condition under control.

feed forward control: Control in which the output of the control loop is adjusted based on the process variable and a second variable that is rationed and biased.

final control element: Component of a control system, such as a valve or contractor, which directly regulates that flow of energy or material to the process.

FM: Factory Mutual Research Corporation; an organization which sets safety standards.

gain: The ratio of the change in output to the change in input which caused it.

hunting: Oscillation or fluctuation of process temperature between setpoint and process variable.

hysteresis: In ON/OFF control, the process variable change necessary to change the output from full ON to full OFF.

icons: Indicators on the face of the controller.

input: Process variable information being supplied to the instrument.

integral: Control action that automatically eliminates offset, or “droop”, between setpoint and actual process temperature. Also “reset.”

internal voltage reference: A precision voltage source within the 545 controller, used to establish internal calibration.

isolation: Electrical separation of sensor from high voltage circuitry. Allows for application of grounded or ungrounded sensing element.

JIS: Japanese Industrial Standards. Also Japanese Industrial Standards Committee (JISC). Establishes standards on equipment and components.

jumper: A wire that connects or bypasses a portion of a circuit on the printed circuit board.

jumper connectors: The connecting device that straddles a jumper to connect or bypass a portion of a circuit on a printed circuit board.

lag, fixed: a consistant, constant delay in detection of a control variable change.

lag, variable : A fluctuating delay in the detection of a control value change (usually the feed forward contribution source).

linearity: The nearness with which the plot of a signal or other variable plotted against a prescribed linear scale approximates a straight line.

linearization: A function the 545 uses to automatically linearize a non-linear signal, either from thermocouple or RTD temperature sensors, through the use of look up tables. The relationship that exists between two variables when the ratio of the value of one variable to the corresponding value of the other is constant over an entire range of possibilities.

linearization, custom: User-definable linearization.

linearization, square root: A function the 545 uses to linearize a non-linear signal corresponding to the flow being measured by flow transmitters.

load line out: A start up output value which is to bring initial output closer to actual steady state output.

load: The demand for input to a process.

loop: A signal path.

loop power: An internal 24-volt current limited power supply used to power 2 or 4 wire transmitter on the input of the controller.

low pass input filter: A method to block fast acting signals (typically noise), while allowing slow acting signals (actual process variable) to pass.

manipulated variable: A quantity or condition which is varied so as to change the value of the controlled variable. (see also control output)

measuring element: An element which converts any system activity or condition into a form or language that the controller can understand.

mechanical relay: (see relay)

menu: Groups of parameters arranged in the software.

microcontroller: A large scale integrated circuit that has all the functions of a computer, including memory and input/output systems.

NEMA 4X: A National Electrical Manufacturers Association standard for specifying a product's resistance to water and corrosion.

normally open: A switched output (i.e, relay, etc.) whose unpowered state has no connection.

normally closed: A switched output (i.e., relay) whose unpowered state provides connection.

noise: An unwanted component of a signal or variable.

noise band: A measurement of the amount of random process "noise" affecting the measurement of the process variable.

offset: The difference between the setpoint and the actual process variable; or adjustment to actual input temperature and to the temperature values the controller uses for display and control.

ON/OFF control: Control of a process variable about a setpoint by turning the output full ON below setpoint and full OFF above setpoint.

open loop: Control system with no sensory feedback.

optimization: The act of controlling a process at its maximum possible level of performance, usually as expressed in economic terms.

output: Action in response to difference between setpoint and process variable.

output modules: Plug in devices that provide power handling to enable process control. These modules are either binary (on/off) such as a relay, or analog (continuously variable) for current loop control.

overshoot: Condition where temperature exceeds setpoint due to initial power up or process changes.

P control: Proportioning control.

PD control: Proportioning control with rate action.

PI control: Proportioning control with auto-reset.

PID control: Proportioning control with auto-reset and rate.

parameter(s): A user-defined variable that specifies how a particular function in the 545 will operate.

position proportioning: A type of control output that utilizes two relays to control an electric motorized actuator.

POWERBACK®: Propriertary algorithm which monitors the PV to make predicitve adjustments to control parameters in order to reduce or eliminate setpoint overshoot at power up or after setpoint changes.

Glossary

POWERTUNE®: Moore Industries' exclusive self tuning function. Consists of an on-demand pretune which calculates PID values or provides preliminary PID values and process information for the second tuning function. Second tuning function is an adaptive tuning algorithm that automatically adjusts PID values whenever a process upset or setpoint change occurs.

pretune algorithm: A method by which the 545 controller initiates an output value change, monitors the manner of the corresponding process variable change, and then determines the appropriate PID control parameters.

primary loop: The outer loop in a cascade system.

process:The equipment for which supply and demand must be balanced, the system under control excluding the equipment that does the control.

process variable: In the treatment of material, any characteristic or measurable attribute whose value changes with changes in prevailing conditions. Common variables are level, pressure and temperature.

proportional band: The change input required to produce a full range change in the output due to proportional control action. The area around the setpoint where proportional control occurs.

RTD: Resistance Temperature Detector. Resistive sensing device displaying resistance versus temperature characteristics. Displays positive temperature coefficient.

ramping: (see setpoint, ramping)

rate: Anticipatory action that senses the rate of change of temperature and compensates to minimize overshoot. Also “derivative.”

rate action: The derivative function of a controller.

rate time: The time interval over which the system temperature is sampled for the derivative function.

ratio: The value obtained by dividing one number by another used to determine proportions.

ratio control: Control in which the setpoint of one loop is a ratio of the process variable of another loop or sensor output.

regulate: The act of maintaining a controlled variable at or near its setpoint in the face of load disturbances.

relay (mechanical): An electromechanical device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other.

relay (solid state): A solid state switching device which completes or interrupts a circuit electrically with no moving parts.

reset: Control action that automatically eliminates offset, or “droop”, between setpoint and actual process temperature. Also “integral”

reset term: (see reset)

relative gain: An open-loop gain determined with all other manipulated variables constant, divided by the same gain determined with all other controlled variables constant.

retransmission: a feature on the 545 which allows the transmission of a milliamp signal corresponding to the process variable, target setpoint or actual setpoint to another devices, typically a chart recorder.

SSR drive: A D.C. on/off signal output for controlling a solid state relay.

sample interval: The time interval between measurements or observations of a variable.

secondary loop: The inner loop of a cascade system.

self tune: A method of automatically calculating and inserting optimum PID parameters by testing system response and timing.

serial communications: The sending or receiving of binary coded data to a supervisory device such as a personal computer or programmable logic controller.

set up: Also called configuration, selection of hardware devices and software routines that function together.

setpoint: An input variable which sets the desired value of a controlled variable.

setpoint, actual: The desired value of a controlled variable that the controller is currently acting upon.

setpoint, deviation from: The number of units difference between the current process variable and the setpoint.

setpoint, ramping: A setpoint which is determined by the ramp function of the controller where over time, the controller variable reaches a desired value.

setpoint, target: The end point of the ramp function.

sheds: In serial communications, when the signal is lost.

slidewire position proportioning: An output algorithm that utilizes a slidewire feedback signal to determine the actual position of the actuator being controlled.

solid state relay: (see relay, solid state)

stability: The desirable condition in which input and output are in balance and will remain so unless subject to an external stimulus.

staged outputs: The set up of two analog outputs, where one analog output varies its signal over a portion of the PID output range, and the second analog output then varies its signal over the remainder of the PID output range.

static discharge: Undesirable current resulting from the discharge of electrostatic energy.

station address: The unique identifier assigned to a device for communications.

thermocouple: Temperature sensing device that is constructed of two dissimilar metals wherein a measurable, predictable voltage is generated corresponding to temperature.

thermocouple break protection: Fail-safe operation that assures desired output upon an open thermocouple condition.

thermocouple upscale burnout (▲): Jumper position that determines whether, when a thermocouple fails, its output is replaced by a millivoltage which will match the thermocouple's maximum value. The jumper connector should be placed in the TC ▲ position.

thermocouple downscale burnout (▼): Jumper position that determines whether, when a thermocouple fails, its output is replaced be a millivoltage which will match the thermocouple's minimum value. The jumper connector should be placed in the TC ▼ position.

three mode control: (See control action PID)

time proportioning control: A control algorithm that expresses output power (0–100%) as a function of percent ON versus percent OFF within a preset cycle time.

time proportioning output: A controller output assigned by software to facilitate time proportional control (typically a relay, SSR, or SSR Drive output).

tracking: A function that defines whether the local setpoint will track the remote setpoint. When the controller is transferred to a local setpoint, that local setpoint value will match the remote process value when the transfer occurs.

transducer:A device which converts information of one physical form to another physical type in its output (e.g., a thermocouple converts a temperature difference into millivolts).

transmitter (2-wire): A device used to transmit data via a two wire current loop. A two-wire transmitter is loop powered.

transmitter (4-wire): A device used to transmit data via a current loop or a DC voltage. A 4-wire transmitter uses 2 wires for data and 2 wires for power.

triac: Solid state switching device used to switch alternating current signals on and off. Triac circuits are sometimes referred to as solid state relays (SSR).

trip point: Value which determines when that set of PID values becomes active.

velocity position proportioning: This is a control technique where valve position is determined by calculating the amount of time it takes to open/close a valve by moving the valve for a portion of that time.

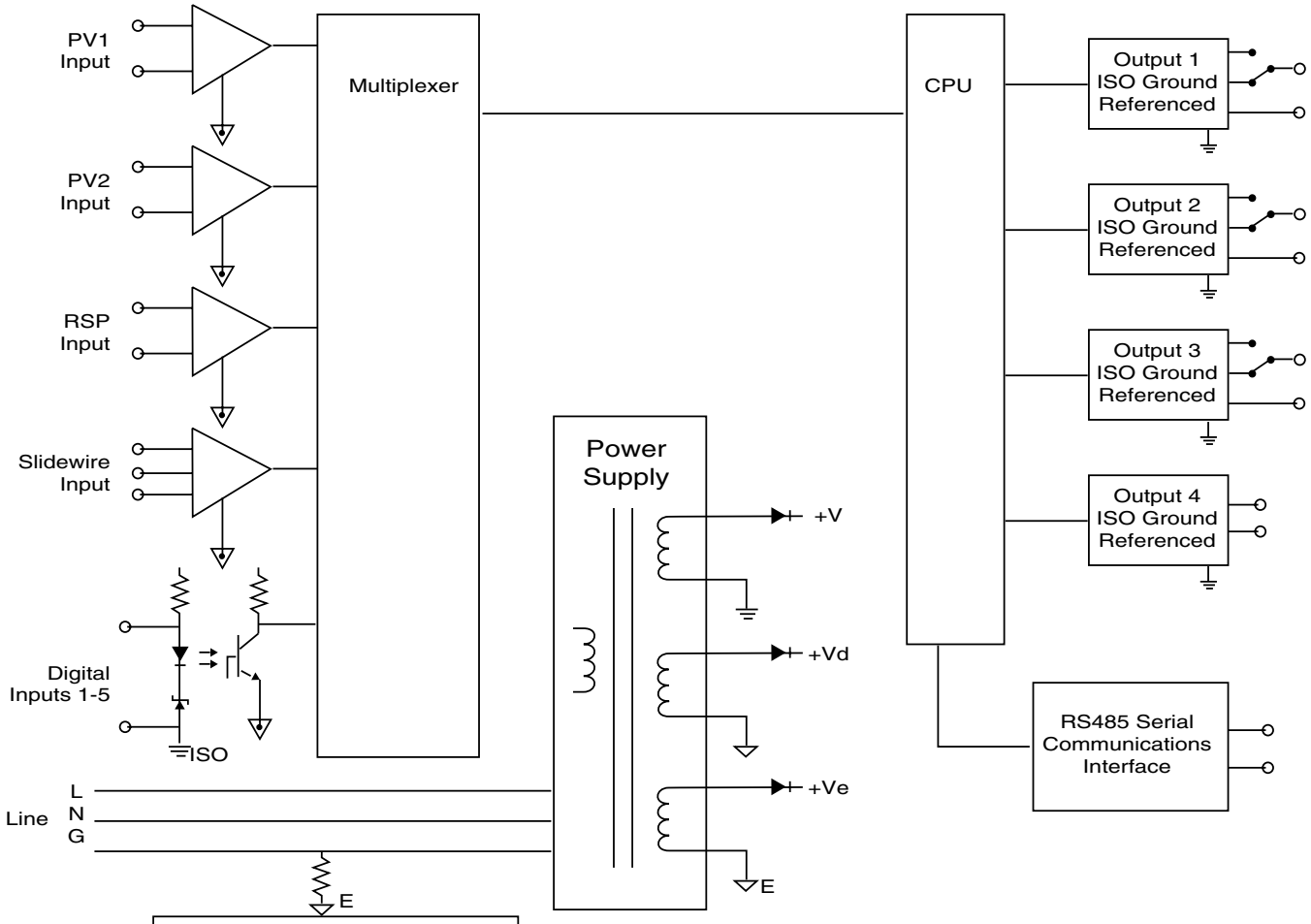
windup: Saturation of the integral mode of a controller developing during times when control cannot be achieved, which causes the controlled variable to overshoot its setpoint when the obstacle to control is removed.

wild stream: In mixing applications that require materials to be mixed to a desired ratio, this is the one part of the material that is uncontrolled.

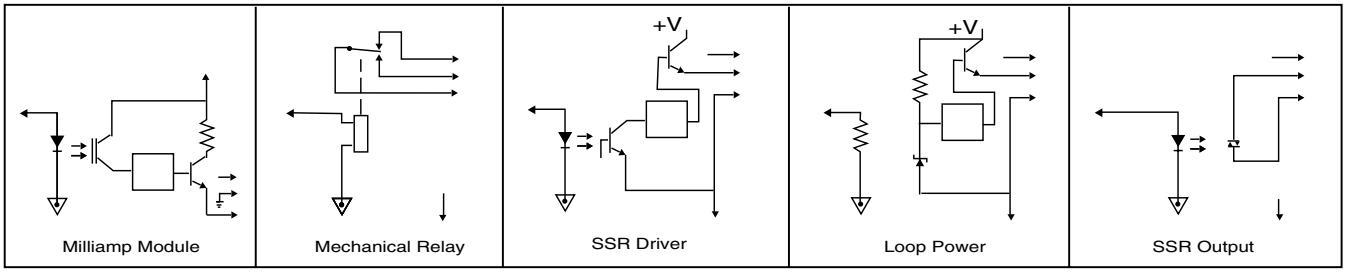
Glossary

APPENDIX 7

ISOLATION BLOCK DIAGRAM



1. Each of the three ground circuits are isolated from each other to withstand a potential of 500 volts for 1 minute, or 600 volts for 1 second.
2. RSP, Slidewire and the PV inputs are isolated to withstand 50 volts peak between each other for 1 minute.
3. PV1 and PV2 have isolation to 10 volts P-P or continuous between each other.
4. Milliamp, Loop Power and SSR Drive modules in output positions 1, 2, 3 and 4 are not isolated from each other.



Isolation Block Diagram

RETURN PROCEDURES

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

   Warranty Repair –
   If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

   Non-Warranty Repair –
   If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:
   a) A note listing the symptoms that indicate the unit needs repair
   b) Complete shipping information for return of the equipment after repair
   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

WARRANTY DISCLAIMER

THE COMPANY MAKES NO EXPRESS, IMPLIED OR STATUTORY WARRANTIES (INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY GOODS OR SERVICES SOLD BY THE COMPANY. THE COMPANY DISCLAIMS ALL WARRANTIES ARISING FROM ANY COURSE OF DEALING OR TRADE USAGE, AND ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY ACKNOWLEDGES THAT THERE ARE NO WARRANTIES IMPLIED BY CUSTOM OR USAGE IN THE TRADE OF THE BUYER AND OF THE COMPANY, AND THAT ANY PRIOR DEALINGS OF THE BUYER WITH THE COMPANY DO NOT IMPLY THAT THE COMPANY WARRANTS THE GOODS OR SERVICES IN ANY WAY.

ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY AGREES WITH THE COMPANY THAT THE SOLE AND EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONCERNING THE GOODS OR SERVICES SHALL BE FOR THE COMPANY, AT ITS OPTION, TO REPAIR OR REPLACE THE GOODS OR SERVICES OR REFUND THE PURCHASE PRICE. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES EVEN IF THE COMPANY FAILS IN ANY ATTEMPT TO REMEDY DEFECTS IN THE GOODS OR SERVICES , BUT IN SUCH CASE THE BUYER SHALL BE ENTITLED TO NO MORE THAN A REFUND OF ALL MONIES PAID TO THE COMPANY BY THE BUYER FOR PURCHASE OF THE GOODS OR SERVICES.

ANY CAUSE OF ACTION FOR BREACH OF ANY WARRANTY BY THE COMPANY SHALL BE BARRED UNLESS THE COMPANY RECEIVES FROM THE BUYER A WRITTEN NOTICE OF THE ALLEGED DEFECT OR BREACH WITHIN TEN DAYS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH, AND NO ACTION FOR THE BREACH OF ANY WARRANTY SHALL BE COMMENCED BY THE BUYER ANY LATER THAN TWELVE MONTHS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH.

RETURN POLICY

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

MOORE INDUSTRIES™

WORLDWIDE • www.miinet.com

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816

Belgium • info@mooreind.be
Tel: 03/448.10.18 • FAX: 03/440.17.97

China • sales@mooreind.sh.cn
Tel: 86-21-62491499 • FAX: 86-21-62490635

Australia • sales@mooreind.com.au
Tel: (02) 8536-7200 • FAX: (02) 9525-7296

The Netherlands • sales@mooreind.nl
Tel: (0)344-617971 • FAX: (0)344-615920

United Kingdom • sales@mooreind.com
Tel: 01293 514488 • FAX: 01293 536852

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Specifications and Information subject to change without notice.

Form M500 V6

500 SERIES
Process Controllers

5 0 0

Hardware Installation and Modification Manual

for Electronic Products Series 531, 532, 535, 545, 555 Model 2

MOORE INDUSTRIES

Installation

INTRODUCTION

This technical brochure provides hardware installation and modification instructions for our controllers:
Series 531, 532, 535, 545, and 555. Use these instructions with the following kits:

Display Assembly Kits
531-632 ..... 531 Display Assembly Kit
532-632 ..... 532 Display Assembly Kit
535-632 ..... 535 Display Assembly Kit
545-634 ..... 545 Display Assembly Kit
555-632 ..... 555 Display Assembly Kit

Output and Communications Module Kits
532-600 ..... 531, 532 Analog Module Kit
535-600* ..... Mechanical Relay Module Kit
535-601* ..... Milliamp Module Kit
535-602* ..... SSR Module Kit
535-603* ..... SSR Drive Module Kit
535-604* ..... Loop Power Module Kit
535-705* ..... RS-485 Communications Module Kit

Power Supply Kit
535-730* ..... 90 to 250VAC Power Supply Kit
535-732 ..... 24VAC/VDC Power Supply Kit

Mounting Kit
535-761* ..... Mounting Kit

Miscellaneous Kits
532-100 ..... 531, 532 Bypass Board Kit
535-188* ..... Rear Terminal Upgrade Kit
535-660 ..... 531, 532, 535, 545, 555 Jumper Kit
535-662* ..... Gasket Kit
(1 Panel Gasket, 1 Bezel Gasket)
535-763* ..... Bezel Retention Screw Kit
535-664* ..... Module Retention Kit
(Retention Plate and Tie Wrap)
535-665* ..... Module Retention Tie Wrap Kit
093-128* ..... Lithium Battery

EPROM Kits
531-740 ..... 531 EPROM Kit
532-740 ..... 532 EPROM Kit
535-741 ..... 535 EPROM Kit (RSP)
535-775 ..... 535 Profiler EPROM Kit (No RSP)
535-776 ..... 535 Profiler EPROM Kit (RSP)
535-740 ..... 535 EPROM Kit (No RSP)
545-740 ..... 545 EPROM Kit (No RSP)
545-741 ..... 545 EPROM Kit (RSP)
555-740 ..... 555 EPROM Kit

Microcontroller (MCU) Board Kits
535-731 ..... MCU Board Kit
545-733 ..... MCU Board Kit with CE Option

Option Board Kits
535-720 ..... 531, 532, 535, 545 Option Board Kit
(No Options)
535-721 ..... 531, 532, 535, 545 Option Board Kit
(Digital Inputs)
535-722 ..... 535, 545 Option Board Kit
(Slidewire Feedback)
535-723 ..... 535, 545 Option Board Kit
(Digital Inputs and Slidewire Feedback)
545-724 ..... 531, 532, 535, 545, 555 Option Board Kit
(RSP)
545-725 ..... 531, 532, 535, 545, 555 Option Board Kit
(Digital Inputs and RSP)
545-726 ..... 535, 545, 555 Option Board Kit
(Slidewire Feedback and RSP)
545-727 ..... 535, 545, 555 Option Board Kit
(Digital Inputs, Slidewire Feedback,
and RSP)

*** Universal Kit (can be used with all 500 Series Controllers)**

HOW TO USE THIS MANUAL:

A. **CAUTION: Static discharge will cause damage to equipment. Always ground yourself with a wrist grounding strap when handling electronics to prevent static discharge.**

B. Before removing or inserting any hardware on the controller, **copy down all configuration parameters**. Also, **replacing the battery, EPROM or MCU Board will erase parameter settings** and they will need to be reset.

C. For all hardware adjustments, **perform steps 1, 2 and 3.**

D. Follow the guide and complete any additional steps as required by your particular application.

E. **Complete** your hardware adjustments with **steps 15, 16, 17, 18, 19 & 20**.

EQUIPMENT

To make any hardware changes to the units, you will need the following equipment:

- Wrist grounding strap
- Small flat blade screwdriver
- I.C. Extractor (if changing the EPROM)
- Phillips screwdriver (#2)
- Wire cutters

INSTRUCTIONS

To Disassemble the Unit

For any hardware modifications, disassemble the unit.

1. With power off, loosen four captive front screws with a Phillips screwdriver. Remove the four screws.

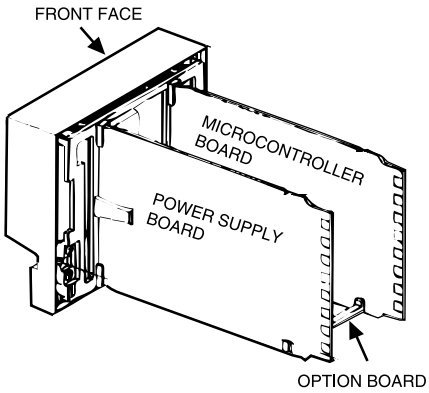


Figure 1
Location of Printed Circuit Boards for Hardware Configuration

2. Slide the chassis out of the case by pulling on front face plate assembly at the bezel (see **Figure 1**).

3. Locate the retention clips holding the front face assembly to the rest of the chassis. Pry apart these retention clips gently with a screwdriver to separate the printed circuit board group from the front face assembly (Photo 3). Take care not to break the clips or scratch the circuit board.

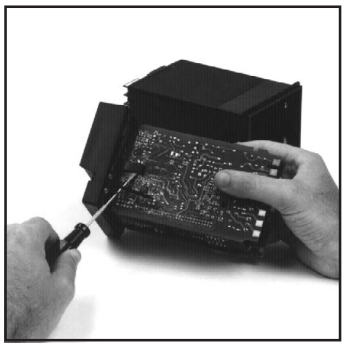


Photo 3. **Pry Clips**

   The Microcontroller Board and Power Supply Board remain attached to the Operator Interface Assembly by wired connectors.

4. The Microcontroller and Power Supply board are attached to either side of the Option board by male/female pin connectors. Use a gentle rocking motion and carefully apply pressure in a uniform direction to separate one of the larger two boards from the Option Board (Photo 4). Be careful not to bend the connector pins. Separate the other board in the same manner.

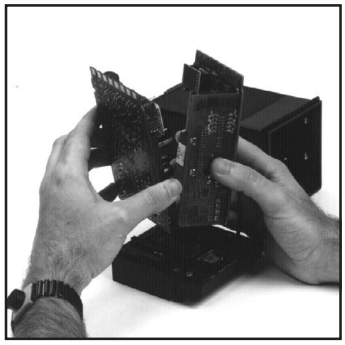


Photo 4. **Separate Boards**

   Figure 2 (opposite page) shows the Microcontroller Board, Option Board and Power Supply Board.

To Add or Change Output Modules

The 500 Series units have provisions for four output modules. The units come factory configured with specified modules installed in appropriate locations. You can make field modifications by properly removing and/or adding the modules into the appropriate sockets.

Three of the output sockets are located on the Power Supply Circuit Board. A fourth output socket is located on the Option Board (refer to **Figure 2**).

5. A retention plate and tie wrap hold Output modules 1, 2, and 3 (on the Power Supply board) firmly in place. To remove the retention plate, snip the tie wrap with wire cutters (Photo 5).

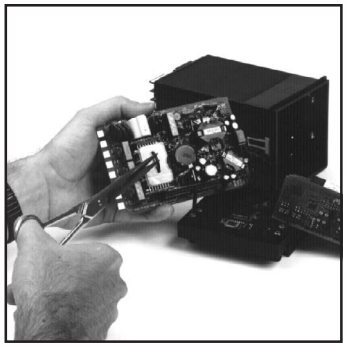


Photo 5.
Remove Retention Plate

CAUTION: Always snip the tie wrap on top of the Retention Plate, as shown in photo 5, to prevent damage to the surface mount components.

6. A disposable tie wrap holds Output module 4 (on the Option board) in place. To remove the module, snip the tie wrap (Photo 6).

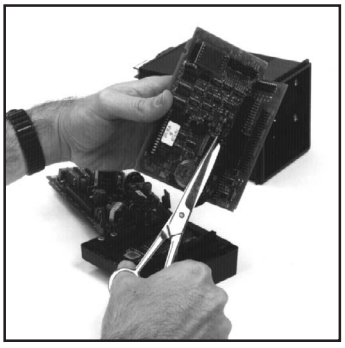
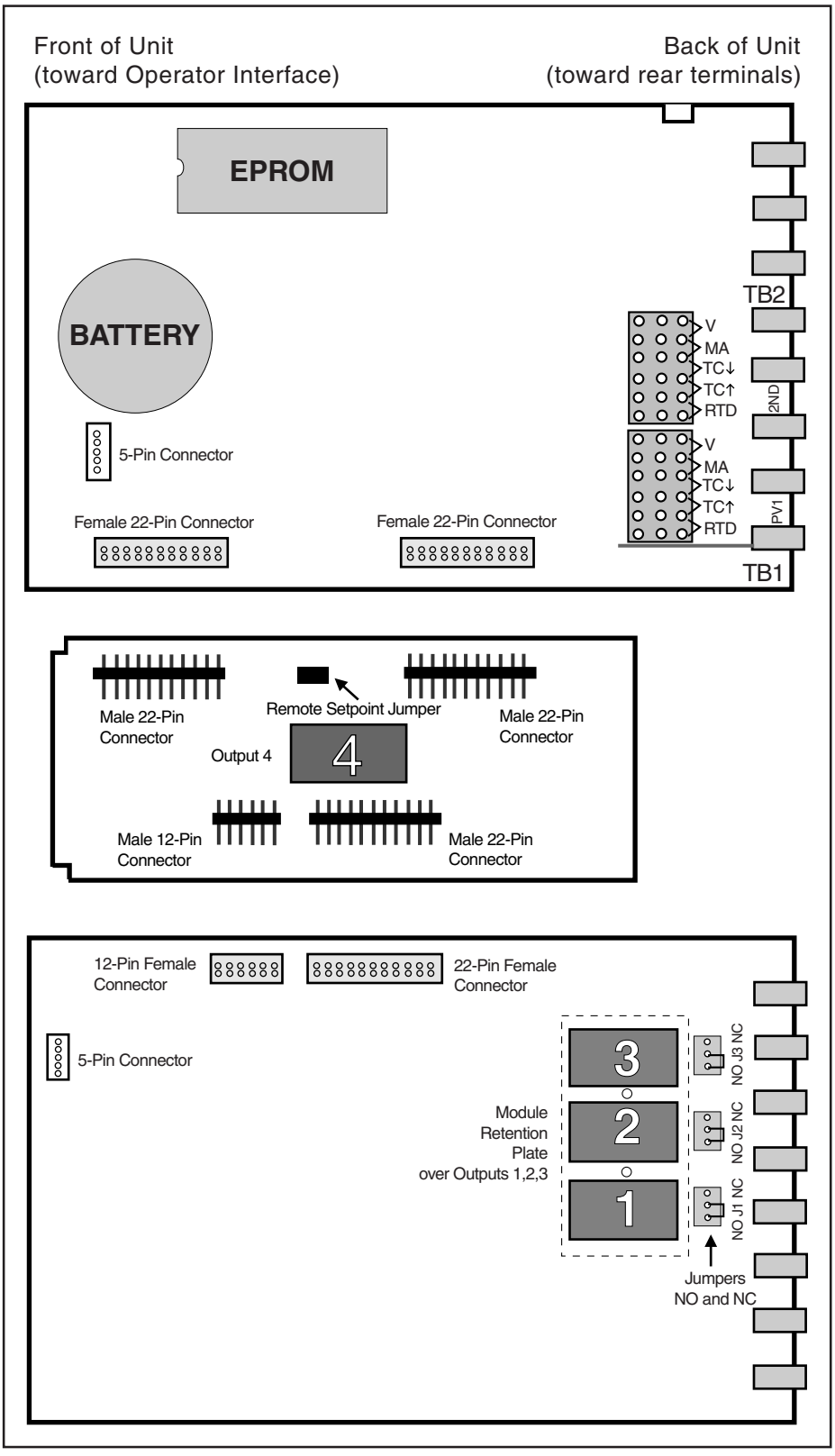


Photo 6.
Snip Tie Wrap on Mod. 4

7. Inspect each module before installation to make sure the pins are straight. Align the pins with the socket holes and carefully insert the module. Press down on the module to seat it firmly on the board.



NOTE:
If you replace the EPROM chip, you must align the notch facing the front of the unit.

NOTE:
The 5- and 22-Pin connnectors on the boards are all keyed so they will only align one correct way.

Figure 2
Microntroller Board, Option Board, and Power Supply Board

8. Replace tie wraps for the Retention Plate and for Output Module 4 with new ones.

   Failure to use these devices may result in a loosening of the module and eventual failure. If you ordered a module separately, it should have come with a tie wrap. An extra set of tie wraps is available by ordering Part #535-665.

   Note: For greatest accuracy, milliamp modules added for retransmission must be calibrated per instructions in Operator's Manual.

To Change the Option Board

9. (See Photos 3 and 4) Replace the existing Option board with the NEW one.

   Note: When adding Option board for 5 digital inputs, associated screw terminal in the rear terminal block must be installed. (See information on page 1 for ordering a Screw Kit.)

To Change the Power Supply or Microcontroller (CPU) Board

10. For the Microcontroller Board, disconnect the 5-pin female connector that wires it to the Display Assembly. Reattach the connector to the new board. You can only orient the connector one way.

    For the Power Supply Board, disconnect the 5-pin female connector that wires it to the Display Assembly. Reattach the connector to the new board. You can only orient the connector one way.

To Change the Display Assembly

11. Disconnect the 5-pin female connector that wires the Microcontroller Board to the Display Assembly. Disconnect the 5-pin female connector that wires the Power Supply Board to the Display Assembly.

12. Attach the new Display Assembly to the boards at the appropriate connectors.

CAUTION

Static discharge will cause damage to equipment. Always ground yourself with a wrist grounding strap when handling electronics to prevent static discharge.

CAUTION
Do not scratch the boards or bend the pins of the connectors.

To Change the EPROM

13. The EPROM is located on the Microcontroller Circuit board (**Figure 2**). It has a white label that list the part number and software revision level. Use an I.C. Extractor to carefully remove the EPROM. If you do not have an I.C. extractor, gently use a small flat blade screwdriver to pry up the EPROM. DO Not bend the EPROM legs.

14. Carefully insert the new EPROM. To position correctly, match the notched end of the EPROM to the markings on the board. The notched end will face towards the display. Make sure all pins are in the socket.

To Reassemble the Unit

15. (See **Figure 2**) Align the connector pins on the Option Board with the connector sockets on the Microcontroller and Power Supply boards. Squeeze them together, making certain all three are properly seated against one another. Check along the side edges for gaps. Make sure the conector is properly aligned. Also, check that the cable assemblies are not pinched.

16. (See **Figure 2**) Align the board assembly with the front face assembly, with the Option board at the bottom (see **Figure 1**). Reinstall the retention clips. Align the boards into the slots of the front face assembly and the clips will snap into place.

17. When you are ready to reassemble the unit, align the boards in the chassis with the case's top and bottom grooves. Press firmly to slide the chassis into the case. If you have difficulty, check that you have properly oriented the chassis, and there are no screws interfering with the case.

18. Carefully insert and align screws. Tighten them until the bezel is seated firmly against the gasket. DO NOT OVERTIGHTEN.

19. If may be necessary to re-configure the software features of your controller or station. Please refer to your User's Manual.

20. To maintain NEMA 4X Rating, you may need new mounting gaskets, order part #535-662. Refer to your user's manual.

Declaration of Conformity

EMC Directive 89/336/EEC

Manufacturer's Name: Moore Industries-International, Inc.
Manufacturer's Address: 16650 Schoenborn Street
North Hills, CA 91343-6196
USA

Declares that the product(s):

Product Name: **500 Series**

	MODEL	/	INPUT	/	OUTPUT	/	POWER	/	OPTIONS	/	HOUSING
Model Number(s):	**500 Series**		*		*		**24 Vdc**		** **H or J**		*

*Indicates any input, output, option and housing as stated on the product data sheet.
**Indicates CE Compliant.

Conforms to the following EMC specifications:
EN61326-1, 1998, Electromagnetic Compatibility requirements for electrical equipment for control use.

Conforms to the following safety standard:
EN 61010-1, 2001

Supplemental Information:
CE option requires CE KIT PN 535-766.

Janurary 9, 2003
Date

Fred Adt
Quality Assurance Director

Robert Stockham
Moore Industries-International, Inc.

European Contact: Your Local Moore Industries Sales and Service Office

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MOORE INDUSTRIES

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816

Australia • sales@mooreind.com.au
Tel: (02) 8536-7200 • FAX: (02) 9525-7296

Belgium • info@mooreind.be
Tel: 03/448.10.18 • FAX: 03/440.17.97

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USA

Declares that the product(s):

Product Name: **500 Series**

	MODEL	/ INPUT	/ OUTPUT	/ POWER	/ OPTIONS	/ HOUSING
Model Number(s):	**500 Series**	*	*	**Universal Power Supply**	** **H or J**	*

*Indicates any input, output, option and housing as stated on the product data sheet.
**Indicates CE Compliant.

Conforms to the following EMC specifications:
EN61326-1, 1998, Electromagnetic Compatibility requirements for electrical equipment for control use.

Conforms to the following safety standard:
EN 61010-1, 2001

Supplemental Information:
CE option requires CE KIT PN 535-765.

August 15, 2005
Date

Fred Adt
Quality Assurance Director

Robert Stockham
Moore Industries-International, Inc.

European Contact: Your Local Moore Industries Sales and Service Office

The Interface Solution Experts • **www.miinet.com**

MOORE INDUSTRIES

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816

Australia • sales@mooreind.com.au
Tel: (02) 8536-7200 • FAX: (02) 9525-7296

Belgium • info@mooreind.be
Tel: 03/448.10.18 • FAX: 03/440.17.97

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2. Provide us with the following documentation:
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   b) Complete shipping information for return of the equipment after repair
   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

WARRANTY DISCLAIMER

THE COMPANY MAKES NO EXPRESS, IMPLIED OR STATUTORY WARRANTIES (INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY GOODS OR SERVICES SOLD BY THE COMPANY. THE COMPANY DISCLAIMS ALL WARRANTIES ARISING FROM ANY COURSE OF DEALING OR TRADE USAGE, AND ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY ACKNOWLEDGES THAT THERE ARE NO WARRANTIES IMPLIED BY CUSTOM OR USAGE IN THE TRADE OF THE BUYER AND OF THE COMPANY, AND THAT ANY PRIOR DEALINGS OF THE BUYER WITH THE COMPANY DO NOT IMPLY THAT THE COMPANY WARRANTS THE GOODS OR SERVICES IN ANY WAY.

ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY AGREES WITH THE COMPANY THAT THE SOLE AND EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONCERNING THE GOODS OR SERVICES SHALL BE FOR THE COMPANY, AT ITS OPTION, TO REPAIR OR REPLACE THE GOODS OR SERVICES OR REFUND THE PURCHASE PRICE. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES EVEN IF THE COMPANY FAILS IN ANY ATTEMPT TO REMEDY DEFECTS IN THE GOODS OR SERVICES , BUT IN SUCH CASE THE BUYER SHALL BE ENTITLED TO NO MORE THAN A REFUND OF ALL MONIES PAID TO THE COMPANY BY THE BUYER FOR PURCHASE OF THE GOODS OR SERVICES.

ANY CAUSE OF ACTION FOR BREACH OF ANY WARRANTY BY THE COMPANY SHALL BE BARRED UNLESS THE COMPANY RECEIVES FROM THE BUYER A WRITTEN NOTICE OF THE ALLEGED DEFECT OR BREACH WITHIN TEN DAYS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH, AND NO ACTION FOR THE BREACH OF ANY WARRANTY SHALL BE COMMENCED BY THE BUYER ANY LATER THAN TWELVE MONTHS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH.

RETURN POLICY

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

MOORE INDUSTRIES™

WORLDWIDE • www.miinet.com

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816

Belgium • info@mooreind.be
Tel: 03/448.10.18 • FAX: 03/440.17.97

China • sales@mooreind.sh.cn
Tel: 86-21-62491499 • FAX: 86-21-62490635

Australia • sales@mooreind.com.au
Tel: (02) 8536-7200 • FAX: (02) 9525-7296

The Netherlands • sales@mooreind.nl
Tel: (0)344-617971 • FAX: (0)344-615920

United Kingdom • sales@mooreind.com
Tel: 01293 514488 • FAX: 01293 536852

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